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PHYSICS ABSTRACTS

SECTION A

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SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 6217-7062

VOLUME 57 **JULY 1954** NUMBER 679

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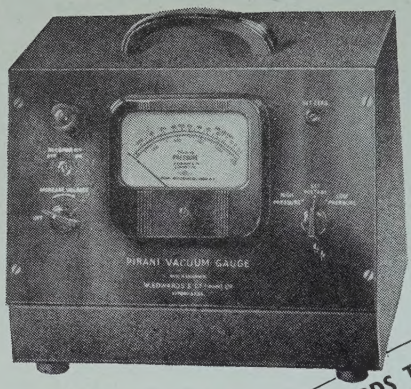

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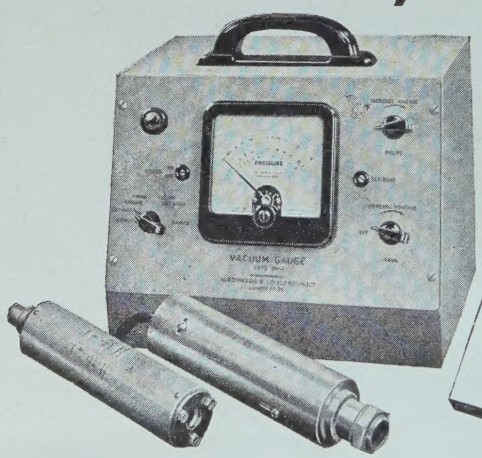

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Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplement published with the Index to Volume 56 (1953). Reprints of the List of Journals (1953) and the Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Tech. J. Brush Group — *Technical Journal of the Brush Group.* The Brush Group Publicity Department, Duke's Court, Duke Street, St. James's, London, S.W.1.

Note

Illuminating Engineering — Address changed to 1860 Broadway (at 61st Street), New York 23, N.Y.

Errata

Subject Index (1953), p. 1389, column 2: **Spectra, flames.** 13th entry ("explosion phenomena observations"), abstract number should read 5152.

Abstr. 732 (1951) line 2: *for* C. C. CLICK *read* C. C. KLICK.

Abstr. 4524 (1952) line 3: *for* **27** *read* **26.**

Abstr. 4738 (1953) line 3: *for* 649 *read* 648.

Abstr. 4696 (1954) line 3: *for* S 1–S 20 *read* S 18–S 20.

Abstr. 5227 (1954) line 14 (first line of p. 672): *for* over *read* compared with.

Author Index (*June*, 1954). For the entry under WATANABE, I., the following three entries should be substituted: WATANABE, D. 6041. WATANABE, I. 5276. WATANABE, J. 6109, 6110.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 975 (1952): **22,** 957 (*May*, 1954).

Abstr. 4254 (1953): **22,** 954 (*May*, 1954).

Abstr. 2142 (1954): **26,** 453 (*May*, 1954).

Abstr. 3162 (1954): **9,** 303 (*March–April*, 1954).

Abstr. 4108 (1954): **45,** 549 (*May*, 1954).

Abstr. 4843 (1954): **22,** 317 (*May*, 1954).

MATHEMATICS 51

512.831 : 538.22

6217. Complex matrices of characteristic polynomials independent of the arguments of the elements. Applications to the study of the magnetic properties of some conjugated hydrocarbons. R. GOUARNÉ AND J. SAMUEL. *C.R. Acad. Sci.* [*Paris*] **238,** 808–9 *Feb.* 15, 1954) *In French.*

By a method similar to that applied previously [Abstr. 2614 (1950)] it is shown which conditions are sufficient that a complex matrix and the matrix of the moduli of its elements have the same characteristic polynomial. Only a few conditions are necessary, so that it is easily possible to verify in which cases the method can be used. A. J. TAYLOR

518.1 : 518.5

6218. Simultaneous linear equations and the determination of eigenvalues. Edited by L. J. PAIGE AND O. TAUSSKY. *Appl. Math. Ser. Nat. Bur. Stand., No.* 29, 126 *pp.* (1953).

This is a report of a Symposium held in 1951. It includes the following papers: (1) *Tentative classification of methods and bibliography on solving systems of linear equation,* G. E. Forsythe; (2) *Systems of equations,* A. M. Ostrowski; (3) *The geometry of some iterative methods of solving linear systems,* A. S. Householder; (4) *Solutions of linear systems of equations on a relay machine,* C.-E. Fröberg; (5) *Some special methods of relaxation technique,* E. Stiefel; (6) *Errors of matrix computations,* P. S. Dwyer; (7) *Rapidly converging iterative methods for solving linear equations,* J. B. Rosser; (8) *Some problems in aerodynamics and structural engineering related to eigenvalues,* R. A. Frazer; (9) *Inclusion theorems for eigenvalues,* H. Wielandt; (10) *On general computation methods for eigenvalues and eigenfunctions,* G. Fichera; (11) *Variational methods for the approximation and exact computation of eigenvalues,* A. Weinstein; (12) *Determination of eigenvalues and eigenvectors of matrices,* M. R. Hestenes; (13) *New results in the perturbation theory of eigenvalue problems,* F. Rellich; (14) *Bounds for the characteristic roots of matrices,* A. Brauer; (15) *Matrix inversion and solution of simultaneous linear algebraic equations with the IBM* 604 *electronic calculating punch,* G. W. Petrie, III; (16) *Experiments on the inversion of a* 16×16 *matrix,* J. Todd; (17) *A method of computing eigenvalues and eigenvectors suggested by classical results on symmetric matrices,* W. Givens; (18) *Computations relating to inverse matrices,* J. Sherman; (19) *Results of recent experiments in the analysis of periods carried out in the Istituto Nazionale per le Applicazioni del Calcolo,* G. Fichera. G. J. KYNCH

518.2

6219. Tables of natural logarithms for arguments between zero and five to sixteen decimal places. *Appl. Math. Ser. Nat. Bur. Stand., No.* 31, 501 *pp.* (1953).

Tables of $\log_e x$, $x = 0(0{\cdot}0001)5$ to 16 decimal places, together with a list of logarithms of common constants. (A reissue of Math. Table 10, Vol. III, Tables of Natural Logarithms, *Nat. Bur. Stand.,* 1941.) G. J. KYNCH

518.2

6220. Tables of circular and hyperbolic sines and cosines, for radian arguments. *Appl. Math. Ser. Nat. Bur. Stand., No.* 36, 407 *pp.* (1953).

The main table gives $\sin x$, $\cos x$, $\sinh x$, $\cosh x$, $X = 0(0{\cdot}0001)1{\cdot}9999$ to 9 decimal places. Auxiliary tables include: these functions, $x = 0(0{\cdot}1)10$ to 10 decimal places; conversion tables, both ways, of radians to degrees (in decimal form or to nearest second); multiples $\frac{1}{2}n\pi$ of $\frac{1}{2}\pi$, $n = 1(1)100$. (A reissue of Math. Table 3, with corrections.) G. J. KYNCH

518.2

6221. Tables of Lagrangian coefficients for sexagesimal interpolation. *Appl. Math. Ser. Nat. Bur. Stand., No.* 35, 157 *pp.* (1954).

Lagrangian interpolation to minutes and seconds of functions of an angle, given at intervals of 1°, requires coefficients at intervals 0(1)60. These coefficients are tabulated for 3-, 4-, 5- and 6-point interpolation formulae. They can be used for the subdivision of any interval to multiples of 1/3600. The introduction explains the use of this table. G. J. KYNCH

518.5

6222. New instrument for rapid evaluation of time-displacement curves. K. W. MAIER. *Rev. sci. Instrum.,* **25,** 207–12 (*March,* 1954).

An instrument is described which makes possible universal evaluation of time-displacement records with regard to velocity and kinetic energy, acceleration and accelerating force, time, and displacement. It consists of a measuring device for reading distances, angles and second derivatives, and a slide rule for direct conversion of the measured values into the desired values. The instrument can be attached to a standard drafting machine of a drawing board. It has many advantages over the present methods of evaluation; no lines need to be drawn on the record, and the instrument permits much more rapid evaluation with fewer errors and can be used by less highly trained personnel. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.042 : 523.51 : 539.155.2

6223. The primeval cosmic abundance of deuterium. G. BOATO. Letter in *Phys. Rev.,* **93,** 640–1 (*Feb.* 1, 1954).

The isotopic composition of hydrogen has been determined for samples of carbonaceous meteorites and compared with that for terrestrial water. It is suggested that the D/H ratio for cosmic matter is close to the terrestrial value. R. A. NEWING

522.61

6224. Monochromatic camera for photography in the far ultraviolet. W. E. BEHRING, J. M. JACKSON, S. C. MILLER, JR AND W. A. RENSE. *J. Opt. Soc. Amer.*, **44**, 229–31 (*March*, 1954).

An ultraviolet monochromatic camera has been constructed which avoids the use of quartz or lithium fluoride optics. The camera makes use of two gratings mounted in the Wadsworth type arrangement in such a way that the dispersions neutralize. The instrument is, thus, a double monochromator, a feature helpful in reducing stray light. Three forms of the camera have been developed, differing only in the manner in which the focus of the final image is achieved. The image is not purely monochromatic but contains a narrow range of wavelengths determined mostly by grating constants and slit widths. A description of the chromatic composition of the image is given and possible applications, including the study of solar limb-darkening in Lyman-α radiation, are discussed. A.

522.615 : 621.389 : 621.317.39

6225. Phototubes observe total solar eclipse. F. J. HEYDEN. *Electronics*, **26**, 176–9 (*Sept.*, 1953).

Type 927 phototubes connected in a bridge circuit were used in conjunction with a d.c. amplifier with a chart moving at 5 in./sec to register the variations in light intensity during an eclipse expedition near Khartoum early in 1952. Simultaneous recording of the accurate time signals relayed from the National Bureau of Standards enabled the instant of minimum light to be estimated to within 0·01 sec. The difficulties encountered due to jamming of the radio signals and the means used to overcome them are discussed. The photometer was kept pointed at the eclipsed sun by means of a modified astrocompass.

G. HOWELLS (R)

523.165

6226. Radioastronomy. II. Results of observations of cosmic radio sources. H. SIEDENTOPF. *Arch. elekt. Übertragung*, **7**, 507–17 (*Nov.*, 1953) *In German.*

For Pt I, see Abstr. 1960 (1954). A review of recent investigations of r.f. radiations from the sun and their variation with time, from isolated sources in the Milky Way and outside it, of the diffuse radiation from the Milky Way and from the region of spiral nebulae, and of the line emission from interstellar hydrogen. Forty-six references. A. WILKINSON

523.5

6227. The physical theory of meteors. V. The masses of meteor-flare fragments. H. J. SMITH. *Astrophys. J.*, **119**, 438–42 (*March*, 1954).

For Pt IV, see Abstr. 1969 (1954). The masses of particles contributing to meteor flares have been computed from their observed durations, by applying the classical equations of meteor ballistics. The flare masses determined in this way are of the order of 10^{-6} g. This value is 10^{-3}–10^{-4} times smaller than the flare masses computed by Jacchia from the total light generated by the flare. It is concluded that a typical meteor flare consists of the simultaneous emission of several thousand microscopic particles rather than the fracture of the parent-body into a few larger pieces. A.

523.5 : 621.396

6228. Radioastronomy. III. Radiolocation meteors. W. DIEMINGER. *Arch. elekt. Übertrag* **7**, 555–60 (*Dec.*, 1953) *In German.*

For Pt II, see Abstr. 6226 (1954). The proce resulting in ionization of meteor trails are discu and the mechanism of the reflection of radio w from such trails is explained. Methods of de mining the characteristics of meteors, namely radiant, the velocity and the height of the ion trail, are described and recent experimental results quoted. Twenty-six references. A. WILKIN

523.67 : 535.3

The λ 4050 group of cometary spectra in the acety oxygen flame. *See Abstr.* 6472

5

6229. On some actual trends in solar observa Y. ÖHMAN. *Scientia* [*Asso*], **89**, *No.* 2, 41–6 (1954

A survey of observations co-ordinated by the in national organization for recording solar phenom and of the instrumental techniques employed. advantages of the coronagraph over the older spec scopic methods for the study of prominences stressed. D. R. BA

52

6230. Relative solar energy distribution in spectral region 10 000–25 000 Å. A. K. PIE *Astrophys. J.*, **119**, 312–27 (*March*, 1954).

Tables are given of the observed relative solar en distribution for zero air mass in the wavelengt terval 10 000–25 000 Å. The observations are b on measures made at Mount Wilson at the S telescope with high resolution—band pass 0·3 The calibration of the spectral response of the eq ment was evaluated by observations of a black-b source and a pyrometric arc. A detailed descrip of the comparison sources and their use is given.

52

6231. Radio evidence of the ejection of very particles from the sun. J. P. WILD, J. A. ROBERTS J. D. MURRAY. *Nature* [*London*] **173**, 532–4 (*March* 1954).

The spectra of short-duration (5–10 sec) burst intense solar radio radiation have been exam over a frequency range of 40 to 240 Mc/s. The with time of the frequency of the low-frequency cu is explained in the same way as the similar ph menon observed with long-duration bursts [Abstr (1954)], viz. that the low-frequency cut-off ma identified with the critical escape frequency at source of radiation, the drift being due to motio the source through the solar atmosphere. interpretation is confirmed by a comparison of spectral characteristics of the same burst obse at harmonic frequencies. The motion of the so for each burst is found, using the Allen–Baum coronal model. Initial velocities of 0·1 to 0·3 o velocity of light are obtained. No outward acce tions have been observed, but decelerations common, indicating that the source is a strea heavy particles rather than protons and electr The observed velocities are consistent with the d time of about 50 minutes between the maximu a solar flare and the associated enhancement cosmic-ray intensity at the earth. In cases w

oth long- and short-duration bursts are observed in ssociation, the long-duration burst always follows the hort-duration one. Comparisons of stream velocities for the two types of burst yield heights of less than 0⁵ km above the photosphere for the origins of the particle streams. M. W. OVENDEN

523.74

6232. A new theory of solar granulation. E. SCHATZMAN. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39,** No. 11, 960–70 (1953) *In French.*

A theoretical argument is developed to explain solar granulation as originating from the passage of compression waves generated in that part of the convective zone nearest to the photospheric surface.

D. R. BARBER

523.74

6233. High-energy microturbulence in the solar photosphere. C. DE JAGER. Letter in *Nature* [*London*] **173,** 680–1 (*April* 10, 1954).

Since the Balmer, Paschen and Brackett series lines of H are much wider in the solar spectrum than can be explained on classical theory it appears that the abnormal widening must be due to some mechanism operating in the solar photosphere and not in laboratory sources. It is here suggested that the responsible mechanism is high-energy microturbulence. Two models have been examined and temperature fluctuations of ± 850°K at $\tau = 1$, and ± 1000°K at $\tau = 2{\cdot}5$ are deduced which correspond to photospheric temperatures of 6500°K and 7200°K respectively. Confirmation of such large temperature fluctuations will necessitate a new approach to the problem of the solar photosphere. D. R. BARBER

523.746

6234. Some properties of sunspot-groups. M. DIZER. *Rev. Fac. Sci. Univ. Istanbul A*, **17,** 387–93 (*Oct.*, 1952) *In French.*

On the basis of the summaries of the Mount Wilson magnetic observations of sunspots, regularly published in the *Publ. Astron. Soc. Pacific*, the actually observed "birthdays" of sunspots are compared with theoretical considerations, derived from a probability theorem developed by v. Mises [*Rev. Fac. Sci. Univ. Istanbul A*, **4,** 145 (1939)]. The observing period 1934–44 furnished 3284 birthdays, which gave rise to altogether 1897 newly-formed spot-groups. If these birthdays are distributed at random, the theorem predicts that on 1843 days no group, on 1066 days one group, and on 375 days more than one group should be born. The observed figures are 1982, 869, and 433, respectively. From the considerable excess of the last-mentioned figure over the theoretical value it is concluded that several of these groups that were formed on the same day appear to be correlated, and their birth probably due to one and the same cause.

A. BEER

523.752

6235. Abundances of metals in the solar chromosphere. S. SCHWARTZ. Note in *Astrophys. J.*, **119,** 296 (*Jan.*, 1954).

Relative abundances (i.e. number of atoms relative to the number of Fe atoms), based on the photometric criterion of "equality of height" for the relevant chromospheric lines, show indications of systematic deviations from the photospheric abundances computed by Claas (1951), especially for Mg, Al and Ca. Further comparisons are needed to establish the reality of these differences. D. R BARBER

523.76

6236. Two models for the interior of the sun. P. NAUR. *Astrophys. J.*, **119,** 365–70 (*March*, 1954).

Two models for the sun, based on the revised data for the proton-proton chain reaction and taking the opacity due to free-free transitions in hydrogen and helium into account, have been calculated. The models differ in the explicit opacity expressions used, but both yield a composition for the interior of the sun of about 0·75% heavy elements, 75% hydrogen, and 24% helium. A.

523.774

6237. Atoms and ions in the sun. C. E. MOORE. *Science*, **119,** 449–56 (*April* 9, 1954).

A non-specialist review of solar spectrum work on which some determinations of cosmic abundances of elements are based.

523.83

6238. The distribution function of velocities of the stellar system in steady state. S. KIKUCHI. *Sci. Rep. Tôhoku Univ. First Ser.*, **36,** 63–72 (*July*, 1952).

Jeans's equation, $\rho = \iiint f\,du\,.\,dv\,.\,dw.$, where ρ is stellar density at point (x, y, z), f is distribution function of velocities, and u, v, w are the velocities of the stars, supposing their masses to be unity, is applied after suitable transformation to a study of the relationship between the distribution function of velocities and the potential, or density of the stellar system. The resulting integral equation is used to obtain the required distribution function when the relation between potential and density is known. Several examples of one-dimensional cases are cited.

D. R. BARBER

523.841.1

6239. An interesting case of equipartition of energy. M. G. FRACASTORO. *R.C. Accad. Naz. Lincei*, **15,** 192–4 (*Sept.–Oct.*, 1953) *In Italian.*

The mechanical energy of matter ejected in a nova outburst is assumed to be equal to the amount of radiant energy liberated and the mass ejected is estimated to be of the order of 10^{-5} solar units.

R. A. NEWING

523.854

6240. Modern investigations into the structure of the Galaxy. J. H. OORT. *Naturwissenschaften*, **41,** 73–80 (*Feb.*, 1954) *In German.*

Existing experimental knowledge of the structure and spatial distribution of the galactic system is reviewed, with particular reference to the rotation of the Galaxy, interstellar gas clouds, and the observed intensity distribution of the 21 cm radio line-emission of H. From the latter an estimate of the kinetic temperature and atomic density of the galactic H-clouds is obtained. D. R. BARBER

523.872

6241. Photoelectric spectrophotometry of planetary nebulae. D. A. MACRAE AND J. STOCK. Letter in *Nature* [*London*] **173,** 589–90 (*March* 27, 1954).

The ratio of the total intensities of the $N_1 + N_2$ lines of [O III] at 4959 Å, 5007 Å to that of Hβ (4861 Å) has been found photoelectrically for a number of

nebulae, using the 24–36 in. Warner and Swasey Schmidt objective-prism telescope. Total intensities of the various spectral images were measured directly with an R.C.A. 1P21 photomultiplier-tube and ancillary equipment. Results for 5 different planetaries, of which photographic measures are also available, confirm the accuracy of the latter.

D. R. BARBER

523.877

6242. On the continuous radiation of δ Cephei. Z. HITOTUYANAGI. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 213–23 (*Nov.*, 1952).

Based on recent observations of colour temperature, Balmer discontinuity and monochromatic magnitudes from measures of the continuous spectrum of δ Cephei, the method of model atmospheres has been used to relate the observational data in terms of the physical parameters, effective temperature and electron pressure. Thus the use of radial velocity curves has been obviated. Variations of photospheric radius with phase are also obtained, and found at variance with similar values derived from radial velocity data. D. R. BARBER

523.877

6243. Curves of growth for δ Cephei. Z. HITOTUYANAGI AND H. INABA. *Sci. Rep. Tôhoku Univ. First Ser.*, **36**, 321–34 (*Dec.*, 1952).

Walraven's method (1948) for deriving curves of growth for the line spectrum of δ Cephei has been modified so as to avoid using solar standard values. Curves of growth for 9 phases are computed for Fe I and Cr I separately. Evidence of micro-turbulence and its systematic variation with phase is found, and phase relations with excitation temperature and atomic abundance are also examined. D. R. BARBER

523.877

6244. On the problem of transfer of radiation in a spherically symmetrical stellar atmosphere for the non-conservative case. K. K. SEN. *Proc. Nat. Inst. Sci. India*, **20**, 12–18 (*Jan.–Feb.*, 1954).

The equation of transfer of radiation in a spherically symmetric atmosphere for non-conservative isotropic scattering has been solved by the method of Chandrasekhar in which integrals are replaced by corresponding Gaussian sums, and first approximation results have been fitted to two boundary conditions one of no incident radiation and the other of a ve weak radiation field penetrating from outside. the second case the variation of outward flux wi optical depth for very large, moderate and wea scattering has been worked out and the results show in a diagram.

523.87

6245. Polyatomic molecules in cold carbon star P. SWINGS. *J. Phys. Radium*, **15**, 193 (*March*, 195 *In French.*

Three peculiar features of the spectra of cold stars are most probably due to the presence of o or more polyatomic molecules, e.g. C_3. The inten u.v. and v. absorption continua in these stars may explained also by the presence of either smoke dust particles in their atmospheres [see Abstr. (1954)]. D. R. BARB

523.87

6246. Compton scattering by electron atmosphere II. Problems with incident normal flux. F. EDMONDS, JR. *Astrophys. J.*, **119**, 425–37 (*Marc* 1954).

For Pt I, see Abstr. 5246 (1954). The proble of the transfer of radiation in an atmosphere free electrons is solved in the first approximation f two sets of boundary conditions involving an incide normal flux, that of the planetary nebula proble and that of no incident diffuse radiation field. the solution, account is taken of the non-coheren character of the electron scattering due to the Dopple shifts arising from a Maxwellian distribution thermal velocities, the red shift of the Compton effe and a non-Doppler blue shift arising from therma motions and first pointed out by Dirac. The latte two effects, designated as "Compton scattering," ar shown to produce asymmetries in spectral lines whic would be very difficult to detect for very high tem peratures, as they are much smaller than the therma broadening. In an appendix, application of th solutions obtained to multiple Compton scattering o low-energy γ-radiation is considered. A

523.877 : 538.3 : 532.5

Some instabilities of a completely ionized plasma *See Abstr.* 6324

PHYSICS 53

53.081

6247. Considerations on metrology. G. TORALDO DI FRANCIA. *Atti Fond. Ronchi*, **8**, 331–45 (*Sept.–Oct.*, 1953) *In Italian.*

Discusses some of the difficulties which are met in modern metrology. In most cases they arise from a false interpretation of the dimensional formalism. This formalism is absolutely conventional and does not help one to understand the real properties of the physical world. In particular the author believes that the so-called dimensionless quantities are physical quantities like the others and deserve their own units. The rule according to which the secondary units are named m/sec^2, sec^{-1} and so on, is the result of a mistake, because the same expression may correspond to many different units. Each unit should have its own name and an equation like [joule] = [newton meter] should only be written to recall the dimensions and not to express an absurd identity of the two sides. When the rationalized system is adopted the units are changed and not the physical quantities. There is failure to see this truism only because, according to the unfortunate rule already mentioned, the same name, as for instance amp/m, applies both to the unrationalized and to the rationalized units. A

53.081.6

6248. Present status of the atomic constants. J. A. BEARDEN, M. D. EARLE, J. M. MINKOWSKI AND J. S. THOMSEN. Letter in *Phys. Rev.*, **93**, 629–30 (*Feb.* 1, 1954).

The least squares adjusted values of h, e and α^{-1}

computed with and without the inclusion of the hyperfine structure (H) or the Lamb shift (L) experiments are compared. The large difference between the 1950 and the present values using the H experiments is attributed to the correction term of order $Z\alpha^2$ occurring in the relation between α and the hyperfine structure separation. The authors state that they see no choice at the present but to include both L and H and to accept the LH values in spite of a 2·4 ratio of error by external to internal consistency.

S. WEINTROUB

FUNDAMENTALS 530.1

530.112

6249. Proposal for a new æther-drift experiment. L. ESSEN. Letter in *Nature* [*London*] **173,** 734 (*April* 17, 1954).

Microwave techniques involved in Furth's suggested experiment [Abstr. 3053 (1954)] are discussed, and it is suggested that the cavity resonator should be used to control the frequency of an oscillator at about 9000 Mc/s. The expected accuracy would be considerably greater than that of the Michelson–Morley experiment. R. A. NEWING

530.12

6250. Successive linearization of Einstein's latest unified field equations. P. UDESCHINI. *R.C. Accad. Naz. Lincei,* **15,** 165–70 (*Sept.–Oct.*, 1953) *In Italian.*

The author's method of obtaining 1st- and 2nd-order approximations to the 1950 field equations [Abstr. 5063 (1951)] are applied to the modified equations introduced by Einstein in 1953.

R. A. NEWING

530.12

6251. A particular solution of Einstein's unified relativistic equations. E. CLAUSER. *R.C. Accad. Naz. Lincei,* **15,** 171–7 (*Sept.–Oct.*, 1953) *In Italian.*

Solutions are obtained for a metric of the form $ds^2 = \gamma(x_1)dx_4^2 - dx_1^2 - \beta(x_1)dx_2^2 - \delta(x_1)dx_3^2$, the electromagnetic field being magnetostatic in the x_1 direction. R. A. NEWING

530.12

6252. Note on the problem of coordinate conditions and equations of motion in general relativity theory. R. TEISSEYRE. *Acta phys. Polon.*, **13,** *No.* 1, 45–9 (1954).

It is shown that in the approximation method of Einstein and Infeld [Abstr. 4074 (1951)] the equations of motion in Newtonian approximation and in the next one are independent of an arbitrary function a_0 appearing in the solutions of the field equations. This result together with the results of Einstein and Infeld concerning a_4 and b_5 lead to the conclusion that in their new approximation method the equations of motion in Newtonian and first beyond Newtonian approximation are uniquely determined by adopting the Newtonian potential as solution of the first field equation. A.

530.12 : 513.81

6253. Significance of Einstein's new field. J. M. THARRATS VIDAL. *An. Real Soc. Espan. Fis. Quim.*, **49(A),** 303–10 (*Nov.–Dec.*, 1953) *In Spanish.*

The non-symmetric g_{ik} determines an anisotropic local space in which is defined a generalized Cayley distance d_{AB} for which $d_{AB} \neq d_{BA}$. The significance of angular measurements in such a space is discussed.

R. A. NEWING

530.12 : 523.11

6254. On the derivation of Friedmann's solution for a new cosmological model. I. R. L. BRAHMACHARY. *Naturwissenschaften,* **41,** *No.* 4, 82–3 (1954).

The solution is obtained for the author's electrically charged fluid model [Abstr. 8207 (1953)].

R. A. NEWING

530.12 : 523.11

6255. On the derivation of Friedmann's equations for a new cosmological model. II. R. L. BRAHMACHARY. *Naturwissenschaften,* **41,** *No.* 6, 136 (1954).

An expression for the time rate of change of the radius of the universe is derived for the author's charged model and compared with that for an uncharged universe. R. A. NEWING

530.12

6256. Fundamental group of transformations in special relativity and quantum mechanics. T. SHIBATA. *J. Sci. Hiroshima Univ. A,* **16,** 61–6 (*July*, 1952).

A 3-parameter group of transformations $x'^{\alpha} = f^{\alpha}(x^1, x^2, x^3, x^4, u^1, u^2, u^3)$ is introduced relating the coordinate systems of two observers in uniform relative motion. The velocity of light is to be an invariant, but invariance with respect to spatial rotations is not demanded. The transformation equations involve certain arbitrary constants and include Lorentz transformations as a special case. R. A. NEWING

530.12

6257. Definition of momentum and mass as an invariant vector of the new fundamental group of transformations in special relativity and quantum mechanics. T. SHIBATA. *J. Sci. Hiroshima Univ. A,* **16,** 487–96 (*May*, 1953).

A momentum 4-vector is defined which reduces to that of special relativity if the additional requirement of invariance under spatial rotations is made.

R. A. NEWING

530.12

6258. Some results deduced from the new fundamental group of transformations in special relativity and quantum mechanics. T. SHIBATA. *J. Sci. Hiroshima Univ. A,* **17,** 67–73 (*Aug.*, 1953).

The transformation equations involve 3 constants d^i interpreted as direction cosines. It is shown that light moving in the direction $\mathbf{d}$ so defined for an observer K, moves in the same direction for K' if the relative velocity is perpendicular to $\mathbf{d}$. If axial symmetry is demanded, then $\mathbf{d}$ defines the direction of the axis of symmetry and the 4-vector momentum reduces to that of special relativity $+ nc[\mathbf{d}; 1](1 - v^2/c^2)^{\frac{1}{2}}/(1 - \mathbf{v} \cdot \mathbf{d}/c)$, where n is an arbitrary constant.

R. A. NEWING

530.12 : 537.1

6259. Foundations of a new unified field of gravitation and electricity. I. J. M. THARRATS VIDAL. *An. Real Soc. Españ. Fís. Quím.*, **50(A)**, 41–4 (*Jan.–Feb.*, 1954) *In Spanish.*

A local space is considered in which the absolute quadric is replaced by a cubic which degenerates into a hyperquadric and a hyerplane. The trilinear form $g_{ikl}X^iX^kX^l = \lambda^3$ then separates into $g_{ik}X^iX^k = \lambda^2$ and $a_lX^l = \lambda$, thus providing a basis for gravitational and electromagnetic fields. R. A. NEWING

530.145 : 531.01

Geometrical mechanics and de Broglie waves. *See Abstr.* 6311

530.145

6260. The extension of the concepts of correlation function and spectral density to a quantum variable. Y. AYANT. *C.R. Acad. Sci.* [*Paris*] **238**, 990–2 (*March* 1, 1954) *In French.*

530.145

6261. Conservation laws in non-local field theories. J. RZEWUSKI. *Acta phys. Polon.*, **12**, *No.* 1, 14–25 (1953).

Expressions for the current density and energy-momentum and angular momentum tensor densities in non-local, classical, field theories are constructed which satisfy differential conservation laws. The tensor densities contain (generally infinite) series of differential operators. Definitions of tensor densities in terms of integral operators are then discussed. It is shown that for scattering problems they must contain differential operators, for bound-state problems they can be defined in terms of integral operators alone. In both cases only integral conservation laws are satisfied. G. FIELD

530.145

6262. Proofs of the uniqueness theorem for some hyperbolic differential equations in theoretical physics. J. PLEBAŃSKI. *Acta phys. Polon.*, **12**, *No.* 3–4, 230–7 (1953) *In German.*

Following Rubinowicz's uniqueness theorem for the solutions of Maxwell's equations, a theorem applicable to certain linear hyperbolic differential equations is proved. This can be readily applied to establish the uniqueness of the solutions of Maxwell's, Dirac's and Proca's equations. W. A. HEPNER

530.145

6263. New description of field. Y. TAKANO AND I. SUZUKI. Letter in *Progr. theor. Phys.*, **10**, 110–11 (*July*, 1953).

The Lorentz invariance of the differential field equations derived in a previous letter [Abstr. 3064 (1954)] is proved, and the quadratic equation and expressions for the Lagrangians derived. G. FIELD

530.145

6264. On the quantum theory of fields. D. RIVIER. *Progr. theor. Phys.*, **9**, 633–62 (*June*, 1953).

A quantization method is proposed which is independent of the canonical formalism. Quantum operators corresponding to classical constants of the motion form a representation of infinitesimal operators in Hilbert space defining the groups of continuous transformations which leave the classical equations of motion invariant. A further requirement of the theory is its independence, at each step, of the spa… like surfaces defining the field variables. T… method is applied to the case of continuous Lore… and gauge transformations, but is confined to the c… of non-interacting matter fields. The connect… between spin and statistics is shown to follow fr… the Lorentz invariance of the theory, and fie… belonging to both kinds of statistics are treated … the same footing. G. FIE…

530.1…

6265. On the solution of the equation of moti… H. KITA. Letter in *Progr. theor. Phys.*, **10**, 231… (*Aug.*, 1953).

The letter discusses the equations of motion … quantized field theories in the form of inhomogeneo… integral equations, in particular the rôle of t… Heisenberg–Møller wave matrix in determining t… properties of the inhomogeneous terms. G. FIE…

530.1…

6266. A note concerning the quantization of spin… fields. J. M. JAUCH. *Helv. phys. Acta*, **27**, *No.* … 89–98 (1954).

It is shown that the anticommutation rules betwee… ψ and $\bar{\psi}$ determine to a large extent those betwee… ψ at different space-time points. The remainin… freedom can be characterized by a real parameter … $0 \leqslant \rho \leqslant 1$. The special case $\rho = 0$ corresponds … the usual method of quantization. The cases $\rho \neq$… can only be used for the description of particles wit… no electromagnetic interaction. The special cas… $\rho = 1$ represents the Majorana field. There is n… physical principle or experimental result known t… rule out the cases $\rho \neq 0$. A…

530.14…

6267. On a regular field theory. II (quantized) J. RAYSKI. *Acta phys. Polon.*, **13**, *No.* 1, 15–28 (1954)

For Pt I, see Abstr. 7427 (1953). A non-local fiel… theory constructed in a domain restricted by tw… hypersurfaces is quantized by a Lagrangian metho… developed by Schwinger. The usual canonical com… mutation relations hold for pairs of points on eithe… of the two hypersurfaces. No representations con… nected with intermediate surfaces exist, and the … Schrödinger equation also does not exist. The two … boundary hypersurfaces are physically distinguished … by the fact that interactions with the measuring … apparatus take place on them. Probability amplitudes … for transitions between states on these surfaces are … computed. A method of a direct quantization of the … field equations is discussed. Sufficient conditions for … the existence of analytical solutions are given in the … case of a quantized field coupled to an external field. … The general case of two interacting quantized fields is … discussed and some necessary conditions for the … existence of regular solutions are formulated. A…

530.145

6268. On the energy of bound states in quantum field theory. I. J. RAYSKI. *Acta phys. Polon.*, **13**, *No.* 1, … 51–65 (1954).

An equation for the eigenvalues of the energy of … two-body systems is derived from field theoretical first … principles. The simple model of non-relativistic … spinless charged fields is treated as an example. Since … the energy eigenvalue problem refers to a fixed time …

instant, the explicit consideration of retardation may be avoided and the instantaneous electromagnetic field may be represented as a sum of two terms: the first in the form of free waves, the second in the form of a stationary solution. The energy field operator splits into several parts: the kinetic energy of charged fields, the energy of photons, the interaction energy between photons and the charged fields, several self-energy terms (due to the interaction between a charged field and the electromagnetic field produced by the same charged field), cross terms (due to the interaction between a charged field and the stationary electromagnetic field produced by the other charged field). The cross terms may be transcribed to the configuration space and yield, besides the Coulomb interaction and the Breit terms, some other corrections. The equation for the energy eigenvalues, i.e. the generalized time independent Schrödinger equation, is written in terms of relative co-ordinates of the two particles. A.

530.145

6269. On the basic ideas of the quantum theory of fields. S. YIFTAH. *C.R. Acad. Sci.* [*Paris*] **238**, 776–8 (*Feb.* 15, 1954) *In French.*

This follows two previous notes [see Abstr. 5253–4 (1954)] on the classification of physical theories according to fundamental constants. The general assumptions underlying quantum field theory are discussed. G. FIELD

530.145

6270. On quantum field theory. II. Non-perturbative equations and methods. E. R. CAIANIELLO. *Nuovo Cimento*, **11**, 492–529 (*May*, 1954).

For Pt I, see Abstr. 3071 (1954). The evaluation of an element of the *U*-matrix between arbitrary initial and final states is reduced to that of a nucleus, whose form depends only upon the number of particles involved and is given explicitly as a perturbative expansion. Nuclei are shown to satisfy systems of "branching equations," which hold independently of perturbation methods and can be taken as the axiomatic foundation of the theory, Lorentz covariance being manifest. Complete systems of such equations are given for the nuclei and their derivatives with respect to the interaction strength λ: all other conceivable equations among nuclei are necessarily deducible from them. All nuclei corresponding to processes involving real bosons can be obtained, with simple integrations, from the nuclei for purely fermionic processes; the branching equations for these are also explicitly given and suffice to define the theory. A nucleus, with its first and second λ-derivatives, satisfies a single integral relation. A variety of approximation methods are immediately deducible from the branching equations; they, while extending and generalizing the known ones, always permit, at least in principle, tests of convergence. Questions of renormalization, existence of solutions, etc., will be studied in the sequel to this paper. A.

530.145

6271. On the magnitude of the renormalization constants in quantum electrodynamics. G. KÄLLÉN. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **27**, *No.* 12, 18 *pp.* (1953).

Using an exact formulation of the renormalization method in quantum electrodynamics which was developed previously [Abstr. 7961 (1952)], it is shown that not all of the renormalization constants can be finite quantities. It is stressed that this statement is made without reference to perturbation theory. A.

530.145

6272. Motion of fast electrons in a magnetic field. A. A. SOKOLOV AND I. M. TERNOV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 537–40 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-137.*

After calculating the energy and the Dirac wave-function of an electron moving in a uniform magnetic field, the authors determine the radius of the orbit and its mean square fluctuation. The intensity of radiation is calculated and the contraction and change in width of the orbit are investigated. The latter is found to be a pure quantum effect. G. FIELD

530.145

6273. A remark on the generalized electromagnetic field theory. Č. MUZIKÁŘ. Letter in *Czech. J. Phys.*, **3**, 256–7 (*Sept.*, 1953).

The general requirements to be satisfied by any non-local theory are seen to lead to a restriction in the possible choice of the (invariant) form factor $\eta(x - x')$. It is shown that, for a theory described by a Lagrangian of the form $L(x) = 1/16\pi \int f_{\alpha\beta}(x)\, \eta(x - x') f_{\alpha\beta}(x') d^4x' - \phi_\alpha(x) s_\alpha(x)/c$ [where $f_{\alpha\beta}(x) = \phi_{\beta,\,\alpha}(x) - \phi_{\alpha,\beta}(x)$], the Fourier transform of the suitably normalized $\eta(x)$, $\varepsilon(K)$, has to satisfy the conditions $\varepsilon(0) = 1$ and $\lim_{K\to\infty} [K/\varepsilon(K)] = 0$. G. FIELD

530.145

6274. On the gauge invariancy and the structure of elementary particle. Y. TAKAHASHI. Letter in *Progr. theor. Phys.*, **10**, 366–7 (*Sept.*, 1953).

The connection between the photon self-energy and the vacuum expectation value of the energy-momentum tensor of a particle in the electromagnetic field is discussed. G. FIELD

530.145

6275. On the transition matrix and the Green function in the quantum field theory. S. TANAKA AND H. UMEZAWA. *Progr. theor. Phys.*, **10**, 617–29 (*Dec.*, 1953).

The Schwinger formalism of the Green-function in quantum electrodynamics is applied to the transition problem of the state. It is shown that the many-body kernel in the Heisenberg representation involves information about the transition of the state and this is directly represented by the repeated use of the one-body kernel G, $\mathfrak{G}$ and the vertex operator Γ_μ defined by Schwinger. Further, the renormalization is discussed without use of the usual perturbation theory, although there remains the difficulty associated with b-divergence. A.

530.145

6276. Green's functions in quantum electrodynamics. J. L. ANDERSON. *Phys. Rev.*, **94**, 703–11 (*May* 1, 1954).

Dyson has shown that the evaluation of the S-matrix for quantum electrodynamics can be reduced to the problem of evaluating certain quantities, S'^F, D'^F and

Γ_μ. By making use of a formula relating the T product of an operator with its corresponding N product, integro-differential equations for S'^F and D'^F are obtained. These equations are identical in form with those given by Schwinger for his Green's-functions, and hence it is concluded that the two formalisms are equivalent. In addition it is shown that all of the quantities introduced by Schwinger can be expressed in terms of a single quantity, S_{vac}, the vacuum expectation value of the S-matrix. The renormalization problem is not discussed. A.

530.145 : 530.12

6277. The photon self-energy problem and microscopic space-time structure. T. KIMURA. Letter in *Progr. theor. Phys.*, **10**, 577–8 (*Nov.*, 1953).

Electromagnetic equations are considered in Riemannian 4-space and the photon self-energy term is removed by renormalizing the $g_{\mu\nu}$ to the Minkowski metric. The procedure leads to an equation of the form $R_{\mu\nu} = -Kg_{\mu\nu}$ which is shown to hold in the e^2-approx. R. A. NEWING

530.145

6278. Relativistic quantum dynamics of a system of interacting particles. J. RZEWUSKI. *Acta phys. Polon.*, **13**, *No.* 1, 29–43 (1954).

The relativistic problem of interacting particles is quantized by use of an approximation method. The solutions of the equations of motion are represented as expansions in powers of the interaction constant. In lowest order of approximation they obey the equations for non-interacting particles and therefore may be quantized directly. Higher order approximations may be expressed in terms of the lowest approximation allowing all physically important quantities to be expressed as expansions in powers of the interaction constant with coefficients depending on the unperturbed operators with simple commutation rules. Equations determining the S-matrix for scattering problems are given. As an example the explicit solution for S is calculated to first approximation.

A.

530.145

6279. On the renormalization programme of field physics. W. ZIMMERMANN. *Nuovo Cimento*, **11**, 416–19 (*April*, 1954) *In German.*

A divergence-free method of determining the functions associated with primitive divergent graphs is outlined for the case of pseudoscalar coupling of nucleons with pseudoscalar mesons. W. A. HEPNER

530.145

6280. A study of gauge-invariant non-local interactions. M. CHRÉTIEN AND R. E. PEIERLS. *Proc. Roy. Soc. A*, **223**, 468–81 (*May* 20, 1954).

The paper investigates the possibility of introducing "non-local" interactions, i.e. interactions represented by four-dimensional integral operations, in order to eliminate divergences in the quantum theory of interacting fields. In particular, a type of equation is discussed which preserves all the required invariance properties, including gauge invariance and macroscopic causality. It turns out that equations of this type still give divergent results. The origin of these divergences is discussed, and it is shown that if there is any way of formulating a finite theory it would have to be very different from the one investigat here.

530.1

6281. Field equations in functional form. S. EDWARDS AND R. E. PEIERLS. *Proc. Roy. Soc. A*, 22 24–33 (*June* 9, 1954).

Starting from the functional equations governi the Green-function of a single nucleon moving in external field with radiative corrections, as given Schwinger, a formulation is developed which rela this Green-function to that of a nucleon moving in arbitrary external field, without radiative correctio In the case of neutral scalar meson theory in whi the recoil of the nucleon is neglected, the Gree function is obtained in closed form. Mass a Green-function renormalizations are easily done com pletely, and the singularities of the solution inves gated, proving to be an interesting illustration of t expected behaviour in more realistic cases.

530.1

6282. On the families of spinor fields. S. ÔNEDA AN H. UMEZAWA. Letter in *Progr. theor. Phys.*, **9**, 685 (*June*, 1953).

Using theorems derived from the quantized fie theory and information from the decay of nucleon the V^0-particle and mesons, three possible ways classifying the known spinor fields into independe commutating "families" (comprising all the anticom muting members of a spinor field) are considered.

W. A. HEPNE

530.1

6283. Analytical representation of general spi T. YAMAMOTO. Letter in *Progr. theor. Phys.*, **10**, 57 (*Nov.*, 1953).

Using an analytical representation of the spi operators, the spin eigenfunctions contain exponen tially decreasing factors; it is suggested that such formulation may be adapted to lead to convergenc factors. W. A. HEPNE

530.1

6284. On the mass spectrum of elementary particles J. RAYSKI. *Acta phys. Polon.*, **13**, *No.* 1, 77–88 (1954)

Generalized field equations (Schrödinger–Gordo and Dirac equations) together with reciprocal supple mentary conditions postulated within the framewor of the non-local (bilocal) field theory are shown t lead to mass quantization. Families of particles ma be classified with respect to (integer or half integer values of the spin and of the isotopic spin. The mas spectra of the nucleon and pion families are given The masses consist of two parts: a proper mass and field mass. The existence of a field mass is responsible for a fine structure of the mass levels. A

530.14

6285. On the relation between phase shift energy levels and the potential. R. JOST AND W. KOHN *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **27** *No.* 9, 19 *pp.* (1953).

A method recently developed by Gel'fand an Levitan [*Dokl. Akad. Nauk SSSR*, **77**, *No.* 4, 557–6 (1951)] is adapted to the problem of determining central potential from the "spectral function" corre sponding to a given angular momentum. (Th

pectral function incorporates the phase shift, binding energies and m additional free parameters if there are n bound states). Two applications are given: an explicit expression is deduced for the totality of potentials with the same phase shift and binding energies as a given potential. Further, it is shown that for a given phase shift the position of the bound states is entirely arbitrary and an explicit example is given which illustrates this fact. Implications for the interpretation of scattering data are discussed. A.

530.145

6286. On the theory of strong coupling. B. T. Geĭlikman. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1, 39–42 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-191.

The formalism of Abstr. 8233 (1953) is discussed and extended to the case where the nucleons move slowly. G. E. BROWN

530.145

6287. Vacuum polarization in the theory of strong coupling. B. T. Geĭlikman. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 2, 225–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-192.

Vacuum polarization terms in the theory developed previously [Abstr. 8233 (1953), 3100 (1954)] are identified. If the meson field Φ_α is separated into ϕ_α and ϕ_α where the former is the classical field and the latter is small, then the non-linearity in the field ϕ_α which gives rise to vacuum polarization is small whereas if Φ_α had not been split the non-linearity would have been large. G. E. BROWN

530.145

6288. The π-nucleon scattering and the damping effect. K. Hasegawa and S. Azuma. Letter in *Progr. theor. Phys.*, **10**, 240–1 (*Aug.*, 1953).

Covariant fourth-order calculations in symmetrical pseudoscalar theory with pseudoscalar coupling are compared with exact values for elastic scattering of 130 MeV π^+ and π^- mesons by protons. The values of the matrix elements are tabulated and show no damping effect for π^+ scattering at 45°, as opposed to π^- scattering. G. FIELD

530.145

6289. Recoil effects in the strong coupling theory. T. Toyoda. *Progr. theor. Phys.*, **10**, 415–20 (*Oct.*, 1953).

The expression for the expectation value of the total energy of a nucleon in a charged scalar meson field is obtained, neglecting nucleon pair formation and assuming the nucleon recoil momentum to be less than its rest mass. The effect of recoil is demonstrated by comparing results for the probability of having given numbers of mesons in the vicinity of the nucleon with those obtained by Tomonaga [Abstr. 2981 (1949)]. G. FIELD

530.145

6290. On the inverse power expansion of the $S_{\text{vac}}[\eta^*, \eta, J]$ and the Green-functions. S. Hori. Letter in *Progr. theor. Phys.*, **10**, 575 (*Nov.*, 1953).

Using the example of the interaction between a charged scalar field and a neutral field, it is pointed out how these functions can be calculated. W. A. HEPNER

530.145

6291. Quantum mechanics of mesons with spin zero and one. I. Úlehla. *Czech. J. Phys.*, **3**, 261–6 (*Nov.*, 1953) *In Russian.*

This paper applies relativistic quantum mechanics to the derivation of the "Zitterbewegung" of a free meson having spin zero and one. I. Introduces into relativistic quantum mechanics the commutation rules for the operators of the co-ordinates q^r ($r = 1, 2, 3$) and the momenta p^r and the equation of motion. It is assumed that the Hamiltonian for a particle with a single self mass will be of the form suggested by Dirac. In order to arrive at equations for particles other than electrons the operator equation, which should be satisfied by the operator H, is replaced by the more general condition. It is further assumed that the spin is given by the vector product with the "velocities" $\dot{q}^r$. II. The algebra is determined of the operators α^i ($i = 0, 1, 2, 3$) occurring in the expression for the Hamiltonian. The equations result in two solutions: in equations for electrons and in equations for mesons with spin zero and one. For the second case, which is dealt with below, a relation is given between the elements α^i and the Duffin–Kemmer matrices β^i ($\beta^0 = \alpha^0$, $\beta^r = \beta^0\alpha^r - \alpha^r\beta^0$). III. Deals with the determination of the characteristic values of the spin operator and with the integration of the equations of motion. Integrating gives for the operators q^r the expressions in which the first two terms correspond to the classical relation between velocity and momentum, and the second two are "oscillating" at high frequency and amplitudes, which are of the order of Compton's wavelength. The character of "oscillations" for a free meson differs from that of a free electron. A.

530.145

6292. Remarks on Lévy's fourth order potential. T. Hamada and M. Sugawara. Letter in *Progr. theor. Phys.*, **9**, 555–7 (*May*, 1953).

The contributions to Lévy's $V_4(r)$ in the non-relativistic region from processes involving a single virtual meson pair are found not to cancel each other out. They cancel almost the whole of the contribution due to two virtual pairs present at the same time. G. FIELD

530.145

6293. On the Duffin–Kemmer algebra. I. Fujiwara. *Progr. theor. Phys.*, **10**, 589–616 (*Dec.*, 1953).

Hitherto unnoticed algebraical features of the Duffin–Kemmer algebra, the so-called meson algebra, have been thoroughly investigated in the general case of n dimensions. Stress is laid on treating it quite generally as an abstract algebra rather than as a matrix algebra, so that no reference is made to explicit representations. The main point consists in explicit construction of the ${}_{2n+1}C_n$ linearly independent bases of the algebra, each transforming as an anti-symmetric tensor for all orthogonal transformations of the n-dimensional β-space. From the physical point of view this tensor character is of paramount importance, for it enables one to get an adequate apparatus for extracting any component from the wavefunction and accordingly to manifest the direct correspondence between the two alternative modes of

formulation of meson theory, the particle formulation and the more usual wave formulation. Recently A. Klein has proposed an interesting procedure to extract a specific component from the meson wave-function, which is now shown to be derivable from the present standpoint; at the same time a considerable amount of new information is obtained in Dirac algebra. A.

530.145

6294. Nucleon isobars and pion scattering. V. Votruba and M. Lokajíček. *Czech. J. Phys.*, **4**, 1–13 (*Feb.*, 1954).

Some properties are found of a new irreducible matrix algebra of degree six, associated with the isotopic spin $(\frac{3}{2}, \frac{1}{2})$. The application of this algebra to the phenomenological description of the nucleon isobars and the scattering of pions by free nucleons is examined. A.

530.145

6295. Construction of potentials from phase shift and binding energies of relativistic equations. E. Corinaldesi. *Nuovo Cimento*, **11**, 468–78 (*May*, 1954)

The problem of constructing the potential $V(r)$ from given S-phase shift and binding energies of the Klein–Gordon equation is treated, and the analogue of the Gel'fand and Levitan integral equation is established. A.

530.145

6296. Low-energy limits and renormalization in meson theory. S. Deser, W. E. Thirring and M. L. Goldberger. *Phys. Rev.*, **94**, 711–23 (*May* 1, 1954).

A technique is developed for deriving rigorous expressions for zero-energy mesonic processes. Making use of the ambiguity of mesonic charge renormalization, the coupling constant is defined by zero-energy pion-nucleon scattering. The threshold photomeson production amplitude is also calculated. The experimental value of the coupling constant defined by scattering is at least an order of magnitude less than that of the coupling constant deduced from the photoproduction data. It is shown that pair suppression effects are absent in both cases. The possibility that the results obtained imply disagreement of pseudoscalar theory with experiment is discussed. A.

530.145

6297. A covariant treatment of meson-nucleon scattering. M. M. Lévy. *Phys. Rev.*, **94**, 460–8 (*April* 15, 1954).

A covariant equation for the meson-nucleon system is presented, in which the renormalization of divergent processes is carried out to all orders. A closed expression is given for their contribution to the wave-function after renormalization, while the contribution coming from finite processes still involves a series expansion. Exact formulae are derived for the scattering phase shifts. A.

530.145

6298. Application of variational methods to intermediate and high-energy scattering. E. Gerjuoy and D. S. Saxon. *Phys. Rev.*, **94**, 478–91 (*April* 15, 1954).

The application of Schwinger's variational principle to scattering by a Yukawa potential is studied. A detailed comparison of the Born approximation, variational and exact results is given in the energy region from 20 to 150 MeV for a potential strength and range appropriate to the ^3S neutron-proton interaction. Comparison with the second Born approximation is also made. The utility of the variational principle is discussed and consideration is given to the high-energy limit. It is judged that for most potentials, the variational formulation without elaborate trial functions will be better than the Born approximation. The relation between the variational principles for the total scattering amplitude and for the phase shifts is analysed. A new formulation intermediate between these two is presented as a compromise between the simplicity of the former and the accuracy of the latter. With the potential studied, use of this formulation leads to considerably better results for the total amplitude than does the original principle. A.

530.145 : 530.1

6299. The classical equations of motion of point particles in neutral meson fields. F. R. Crownfield, Jr and P. Havas. *Phys. Rev.*, **94**, 471–7 (*April* 15, 1954).

The special relativistic equations of motion of point particles interacting with neutral scalar or vector meson fields are redetermined by applying a method originally developed by Infeld and Wallace for the electromagnetic case, which is based on the linearized equations of general relativity. This method, which is free of ambiguity, leads to the equations obtained previously by several authors by the method originated by Dirac in electrodynamics, but differs from some of the results of Majumdar and Apte, who used a simplified version of the Infeld–Wallace method which did not have recourse to general relativity. A.

530.145 : 539.165.2

The pseudoscalar interaction and the beta spectrum of RaE. *See Abstr.* 6856

530.145

6300. Convergence of iterative methods. T. Kikuta. *Progr. theor. Phys.*, **10**, 653–72 (*Dec.*, 1953).

For various iterative methods in the eigenvalue problem which are used to solve bound states and scattering problems, a coefficient of convergency is introduced which indicates not only the convergency condition when the iteration is performed endlessly, but also the efficiency of successive approximations for any finite step. In this way the convergency properties of these iterative methods are investigated from a common standpoint, though the main new results stated in this paper concern the scattering problems. Comparing the convergence properties for Schwinger's iterative method and Born's successive approximation in the scattering problem, shows the former to be considerably superior in the low-energy domain, while for high energies the latter is simpler. A more efficient iterative method is presented, and its application to the variational technique is discussed. The method is shown to be convenient since no troublesome procedure solving the secular determinant is needed. A.

530.145

6301. Perturbation theory of relativistic eigenvalue problem. N. MUGIBAYASHI AND M. NAMIKI. Letter in *Progr. theor. Phys.*, **10**, 108–9 (*July*, 1953).

A simple perturbation theory, which includes Salpeter's results but is valid even in the presence of an external field and for a non-instantaneous unperturbed interaction, is presented. It can be applied, for example, to the calculation of the triplet splitting of the He atom. W. A. HEPNER

530.145

6302. The α-correspondent operators in wave mechanics. MOREL-VIARD. *C.R. Acad. Sci.* [*Paris*] **238**, 992–4 (*March* 1, 1954) *In French.*

The function Φ is α-correspondent to ϕ if $\Phi = e^{i\alpha}\phi$. Wavefunctions in two different Galilean systems of reference can be made α-correspondent (in which case $\alpha = mv/\hbar$ where v is the velocity with which one system moves with respect to the other and m is the mass of the particle described by the wave-function). G. E. BROWN

530.145

6303. The collective description of many-particle systems. (A generalized theory of Hartree fields.) T. KINOSHITA AND Y. NAMBU. *Phys. Rev.*, **94**, 598–617 (*May* 1, 1954).

A systematic method of handling a system composed of a number of particles and an intermediary Bose field has been developed. The main idea consists in linearizing the interaction by taking certain average values so that it may be amalgamated to the free Hamiltonian. Only the remaining fluctuational interaction is treated by perturbation theory. The effect of the averaged interaction appears in the form of two generalized Hartree fields associated with the particle and the Bose quantum, respectively. The self-consistent equations for these Hartree fields are derived from an analysis of the *S*-matrix, keeping close analogy to the renormalization procedure in quantum electrodynamics. The formalism includes such approximations as the Bohm–Pines, Hartree–Fock and Thomas–Fermi theories as special cases. General criteria about the validity and plausibility of the picture involved in the present formulation are discussed from various points of view. A.

530.145 : 530.162

6304. The continuous spectrum approximation in quantum statistics. P. T. LANDSBERG. *Phys. Rev.*, **94**, 469–71 (*April* 15, 1954).

A class O of systems of non-interacting quantum-mechanical particles is defined, so that it is often justifiable to approximate a given system of particles as a system of class O. A "limit L" is defined as the limiting case which arises if the number of particles N and the volume V of the system are both allowed to tend to infinity so as to keep the ratio N/V a finite and non-zero constant. It is shown that if one wishes to calculate the mean value of an extensive variable, as averaged over a canonical or over a grand canonical ensemble, for a system of class O in the limit L, one can apply the continuous spectrum approximation directly to the particle quantum states (excepting, possibly, the states which belong to the lowest energy level) without using a limiting process. A.

530.162

6305. The distribution function of degenerating ensemble. (An addition to "Generalization of statistics.") T. OKAYAMA. Letter in *Progr. theor. Phys.*, **10**, 583–5 (*Nov.*, 1953).

See Abstr. 2962 (1953). Discussion of the rôle played by electron spin in Fermi–Dirac statistics, both for ideal gases and for real gases with interactions. E. H. SONDHEIMER

530.162

6306. Quantum corrections to the transport coefficients of gases at high temperatures. J. DE BOER AND R. B. BIRD. *Physica*, **20**, 185–98 (*April*, 1954).

The WKB method is applied to the quantum-mechanical formulation of the transport coefficients. The use of the lowest order terms in the WKB expansion of the phase-shifts gives the classical formulae for the transport coefficients. Higher order terms in the expansion yield expressions for quantum corrections to the transport coefficients proportional to even powers of Planck's constant. Calculations for an inverse twelfth-power potential indicate that the first quantum correction is of the same order of magnitude as the precision of experimental transport coefficient measurements. A.

530.162 : 536.7

6307. Markoff random processes and the statistical mechanics of time-dependent phenomena. II. Irreversible processes in fluids. M. S. GREEN. *J. chem. Phys.*, **22**, 398–413 (*March*, 1954).

For Pt I, see Abstr. 8690 (1952). The procedures developed in Pt I are applied to the specific case of irreversible processes in fluids. The gross variables are chosen to be a finite number of the plane-wave expansion coefficients of the local particle, momentum and energy densities. As an example, the gross variables describing the local particle density are $\sum_{i=1}^{N} \exp i\mathbf{k} \cdot \mathbf{x}_i$, where $\mathbf{p}_i$ and $\mathbf{x}_i$ are the momentum and position of the ith molecule and N the total number. $\mathbf{k}$ runs over a finite number of values which are all small compared to the reciprocal mean distance between molecules. The phenomenological equations are derived and expressions are given for the viscosity, diffusion and heat conductivity in terms of the autocorrelation coefficients of certain phase functions. These expressions are supposed to be valued for both liquids and gases. They are shown to coincide with the Chapman–Enskog expressions for dilute gases. A.

530.162 : 536.7

6308. Extension on Onsager's theory of reciprocal relations. I. S. R. DE GROOT AND P. MAZUR. *Phys. Rev.*, **94**, 218–24 (*April* 15, 1954).

A generalization of Onsager's proof for reciprocal relations between irreversible processes is developed in such a form that it can be used for vectorial and tensorial phenomena. This is achieved by means of an extension of the fluctuation formalism used by Onsager. The method is applied to heat conduction, diffusion, viscosity and cross-effects in anisotropic systems, and reciprocal relations are derived for these phenomena. A.

530.162 : 536.7

6309. Extension of Onsager's theory of reciprocal relations. II. P. MAZUR AND S. R. DE GROOT. *Phys. Rev.*, **94**, 224–6 (*April* 15, 1954).

The extension of Onsager's theory of reciprocal relations between irreversible processes, developed previously by the authors, is applied to electric conduction in anisotropic crystals, and the symmetry properties of the conduction tensor are derived. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.01

6310. The period and amplitude of the Van der Pol limit cycle. E. FISHER. *J. appl. Phys.*, **25**, 273–4 (*March*, 1954).

The amplitude and period of the limit cycle of the Van der Pol equation, $\ddot{y} + y = \nu\dot{y}(1 - y^2)$, are found for all values of ν by joining graphically the results of solutions about $\nu = 0$ and $\nu = \infty$. A.

531.01 : 530.145

6311. Geometrical mechanics and de Broglie waves. J. L. SYNGE. *Cambridge: The University Press* (1954) vi + 167 *pp*.

The term "geometrical mechanics" can best be understood by the optical analogy. In optics, geometrical optics consists of the tracing of rays of light and is useful when the wavelength is short compared to the dimensions of the objects considered. The correct optical theory described by Maxwell's equations is much too cumbersome to work with in most problems, so geometrical optics is supplemented by concepts of waves, interference, etc., in order to handle problems in which the wavelength cannot be neglected. In an analogous way, Newtonian mechanics, when formulated with the principle of Maupertuis, $\delta \int v ds$, exhibits the ray-wave relationship immediately as part of the calculus of variations. Such a formulation of mechanics is called "geometrical mechanics." In chapters II and III of this book the three-dimensional formulation of Hamilton of geometrical mechanics is generalized to four dimensions and applied to several examples. In chapter IV a primitive quantization is carried out and de Broglie waves are introduced to make the step, which in the analogous case of optics consists in going from geometrical to physical optics (Schrödinger's equation is analogous to Maxwell's equation for the precise description of the system). In chapter V the general theory is applied briefly to the two-body problem. G. E. BROWN

531.224.7

6312. Applications of the method of superposed networks to various elasticity problems. L. MALAVARD AND J. BOSCHER. *C.R. Acad. Sci.* [*Paris*] **238**, 1093–5 (*March* 8, 1954) *In French.*

A brief description is given of an electrical analogy method based on Kirchhoff's laws and of its application to the study of the flexure of homogeneous plates of constant or of variable thickness and of the elas properties of anisotropic plates and plates on elastic foundation. H. J. H. STAR

531.383 : 539.

6313. The instability of the Tippe-Top explain by sliding friction. S. O'BRIEN AND J. L. SYNGE. *Pr Roy. Irish Acad. A*, **56**, 23–35 (*Feb.*, 1954).

The authors agree with Braams and Hugenho [Abstr. 7056 (1952); 2215 (1953)] who attribute t instability to sliding friction. Instead of the ord nary law of sliding friction a law of viscous friction employed in which the frictional force is proportion to the velocity of sliding. These two laws are equiva lent at critical stability. The method yields linea equations leading to a simple criterion for stability. T. C. TO

MECHANICAL MEASUREMENTS 531.7

531.717.1 : 537.53

6314. Layer-thickness measurement with X-rays B. HESS. *Z. angew. Phys.*, **6**, *No.* 1, 19–22 (1954) *German.*

Describes a method of measuring the thickness of layer which involves the measurement of the ionizatio produced by secondary electrons arising from the irradiation of the layer by X-rays. J. THEWLI

531.787.

6315. Calibration of sensitive differential pressure devices. R. A. GROSS. *Rev. sci. Instrum.*, **25** 218–20 (*March*, 1954).

A new technique for the calibration of static differential pressure sensing devices is described. The system of calibration is explained and the necessary equations are developed in detail. The basis of this technique for producing known values of very small static pressure differences is that of the air centrifuge. This method has been employed for developing pressure differences as small as 10^{-6} lb/in.^{2} A.

531.787.9

6316. A semi-automatic electrical manometer designed to calibrate a Mach–Zehnder interferometer system for the recording of transient pressure changes. T. F. W. EMBLETON. *Rev. sci. Instrum.*, **25**, 246–7 (*March*, 1954).

A pressure-sensitive element is described which provides an electrical output proportional to the pressure difference existing on the two sides of the element. By means of an electrically conducting lead in each arm of a U-tube manometer the liquid (mercury) represents the contact point of a potentiometer; under the influence of an applied pressure this contact point is moved electrically. In the application described, the variation of light intensity at a point in the fringe system of an optical interferometer is calibrated as a function of density or pressure changes occurring in one of the interfering light beams. A.

MECHANICS OF FLUIDS 532

532.13 : 541.64

6317. Non-Newtonian viscosity of dilute high polymer solution. I. Preliminary observation and effect of solvent. E. WADA. *J. Sci. Res. Inst.* [*Tokyo*] **47,** 149–58 (*Dec.*, 1953).

Non-Newtonian viscosity of fractionated polymethyl metacrylate solutions in various solvents was measured over a wide range of shear rate with a Hess-type horizontal viscometer. Effects of solvent, temperature, concentration, degree of polymerization and plasticizer were investigated. Viscosity decreases with increasing rate of shear and (*a*) the better the solvent, (*b*) the higher the degree of polymerization and the concentration, and (*c*) the lower the temperature, the more markedly non-Newtonian behaviour was observed. In all cases the observed values were represented by a power law $Q/R^3 = K(PR/2L)^N$ within about $5 \sim 1000$ dynes/cm^2 of shearing stress. A.

532.13 : 541.64

6318. Non-Newtonian viscosity of dilute high polymer solution. II. Effects of concentration, temperature and degree of polymerisation; method of measuring true intrinsic viscosity. E. WADA. *J. Sci. Res. Inst.* [*Tokyo*] **47,** 159–67 (*Dec.*, 1953).

Non-Newtonian viscosity was measured at low rates of shear with an improved horizontal viscometer and a modified Ostwald viscometer. Viscosity-gradient curves clearly show antisigmoidal shape having a horizontal tangent at the origin. As the concentration and the degree of polymerization decrease and the temperature increases, initial linear parts of the curves extend towards high rate of shear. The shear dependence of the viscosity at zero concentration was in accord with Kuhn's theory within the experimental error in the measured range of shear rate. From these experimental results a new method of measuring the true intrinsic viscosity was proposed. A.

532.13 : 541.64

6319. Non-Newtonian viscosity of dilute high polymer solution. III. Tobacco mosaic virus solution. E. WADA. *J. Sci. Res. Inst.* [*Tokyo*] **47,** 168–71 (*Dec.*, 1953).

This was measured and the results compared with Kuhn's and Saito's theory concerning prolate spheroid solution. Axial ratios $P = a_1/a_2$ (where a_1 is the major and a_2 the minor axis) obtained were: (1) 20 for $c = 1{\cdot}14$ g/l (assuming $a_2 = 15$ mμ in the theory), (2) 19 for $c = 1{\cdot}14$ g/l and 17 for $c = 0$ (Simha's or Kuhn's theory), and (3) 18·8 for $c = 0$ (light scattering measurement). A.

532.133 : 534.2

6320. On the viscosity of volume. I. A. CARRELLI AND F. CENNAMO. *Nuovo Cimento*, **11,** 429–35 (*May*, 1954) *In Italian.*

According to a theory developed by Eckart, a consequence of the existence of a second viscosity coefficient is the generation of a fluid current in a medium traversed by ultrasonic waves; Liebermann has succeeded in observing this motion and measuring this second coefficient for some liquids. In the present paper measurements are reported for water in experimental conditions nearly similar to those of Liebermann, results being obtained according to theory; but there are some peculiarities which require further experimental investigation; for instance the considerable variation of the second coefficient for water at frequencies of 1·8, 3·0 and 4·2 Mc/s. A.

532.137

6321. Precise measurements with Bingham viscometers and Cannon master viscometers. J. F. SWINDELLS, R. C. HARDY AND R. L. COTTINGTON. *J. Res. Nat. Bur. Stand.*, **52,** 105–20 (*March*, 1954).

A critical study has been made of the techniques used at the National Bureau of Standards with Bingham viscosimeters and Cannon kinematic viscosimeters. All corrections applicable to measurements with these instruments were critically examined. Instruments of each type were calibrated using the viscosity of water at 20°C as the primary viscosity standard. The viscosimeters were used to determine the viscosities of four hydrocarbon liquids in the range 0·4 to 40 centipoises. With each liquid, the values obtained in the two types of viscosimeters were in agreement by 0·05% or better, indicating that no gross error was involved in the use of either instrument. It is considered, however, that the inherent relative simplicity of operation of the kinematic viscosimeter makes it a preferable instrument for this type of measurement. A.

532.137

6322. A simple electromagnetic microviscometer for semi-transparent liquids. J. HART. *J. sci. Instrum.*, **31,** 182–4 (*May*, 1954).

Observation of the motion of a small steel sphere through 0·04 ml of semi-transparent biological secretion contained in a glass tube gives a measure of the apparent viscosity and an indication of the elastic properties of the specimen. The sphere is propelled by the non-uniform magnetic field of a solenoid energized by a known variable direct current. A.

532.5 : 533.6

6323. Modern developments in fluid dynamics. Edited by L. HOWARTH, H. B. SQUIRE AND C. N. H. LOCK. *Oxford: Clarendon Press; London: Oxford University Press* (1953) Volume I: xvi + 476 *pp.* Volume II: viii + 400 *pp.* [*The Oxford Engineering Science Series.*]

Review in *Nature* [*London*] **173,** 604–5 (*April* 3, 1954).

532.51 : 538.3 : 523.877

6324. Some instabilities of a completely ionized plasma. M. KRUSKAL AND M. SCHWARZSCHILD. *Proc. Roy. Soc. A*, **223,** 348–60 (*May* 6, 1954).

Two cases of equilibrium for a highly conducting plasma are investigated for their stability. In the first case, a plasma is supported against gravity by the pressure of a horizontal magnetic field. This equilibrium is found unstable, in close correspondence to the classical case of a heavy fluid supported by a light one. The second case refers to the so-called pinch effect. Here a plasma is kept within a cylinder by the pressure of a toroidal magnetic field which in

turn is caused by an electric current within the plasma. This equilibrium is found unstable against lateral distortions. A.

532.517

6325. Some observations on the behaviour of liquids between rotating rollers. W. H. Banks and C. C. Mill. *Proc. Roy. Soc. A*, **223**, 414–19 (*May* 6, 1954).

Direct observations of cavitation in liquid films separating two rotating rollers are reported. The speed of rotation and separation of the rollers at which cavitation sets in is consistent with hydrodynamical theory. The onset of cavitation is sharp at a rarefaction of about 2 atm for castor and paraffin oils. A.

532.527

6326. The structure of vortex rings. B. Stuke. *Z. Phys.*, **137**, *No.* 3, 376–9 (1954) *In German.*

The motion and development of structure in vortex rings was studied by photographing drops of paraffin in amyl alcohol with some water added. The drop, first of all, assumes the form of a disk, then a slight central depression occurs at the back of the disk and grows rapidly as the disk spreads. This process is repeated at the front until finally the disk becomes so thin that it punctures, and a symmetrical ring is produced. The ring disintegrates rapidly, and most of the paraffin runs together into two or three drops which, provided they are sufficiently large, repeat the process. The motion of drops in a medium offering only very slight resistance to motion, so that circulation must be present in the drops, is briefly discussed.

J. S. G. THOMAS

532.542

6327. Flow through uniformly-tapped pipes. C. Codegone. Letter in *Appl. sci. Res. A*, **4**, *No.* 1, 76 (1953).

In reference to the paper by Van der Hegge Zijnen [Abstr. 3345 (1952)], the author establishes an expression for the pressure drop along the tapped pipe and states that, for laminar flow, the pressure drop $\simeq 1/2$ and not $\simeq 1/3$ of the pressure drop for the same pipe without lateral orifices with the whole rate of flow, Q_0, at the end. J. S. G. THOMAS

532.57 : 621.3.015.1 : 621.317.39

6328. Electromagnetic velometry. II. Elimination of the effects of induced currents in explorations of the velocity distribution in axially symmetrical flow. A. Kolin and F. Reiche. *J. appl. Phys.*, **25**, 409–13 (*April*, 1954).

For Pt I, see *J. appl. Phys.*, **15**, 150–64 (*Feb.*, 1944); Abstr. 1144 B (1944). The distribution of electrical potential in a conduit carrying an axially symmetrical flow through an homogeneous magnetic field, which is perpendicular to the flow, is analysed. It is shown that it is possible to eliminate the difficulties arising from induced currents in electromagnetic determinations of the velocity distribution by measuring the potential gradient $\partial\phi/\partial y$ (y being $\perp H$ and $\perp v$) along a diameter bisecting the angle between the H axis and the Y axis. The knowledge of the distribution of $(\partial\phi/\partial y)_{45°}$ at a known discharge through the conduit determines the velocity distribution $v = f(r)$. A.

532.574 : 621.317.7

6329. Electronic flowmeter system. H. P. Kalmu *Rev. sci. Instrum.*, **25**, 201–6 (*March*, 1954).

A flowmeter system is described which gives con tinuous readings of flow velocity, with a fast rate c response. The "upstream-downstream" method i used in which velocity of a fluid is determined b measuring the phase difference between an upstrea and downstream ultrasonic wave of, say, 100 00 cycles. The functions of the transmitting and receivin transducers are interchanged at a fast rate, sa 100 c/s, allowing the use of a synchronous rectifier In this way, no long-time stability of the phasemete is required so that very small flow rates can b measured. Velocities as low as 0·1 cm/sec were successfully measured. A special commutator switch with very low transfer capacitance and, as an alternative, an electronic switch are described. The transducers used are barium titanate crystals mounted so that their contact with the fluid is avoided. A.

532.59 : 534.011/.012

6330. Elementary derivation of equations for wave speeds. A. J. O'Leary. *Amer. J. Phys.*, **22**, 327–34 (*May*, 1954).

The equations for the speed of waves in the following cases are derived in an elementary way: transverse waves along a stretched wire and through an elastic solid; longitudinal waves through a fluid in a uniform tube, through a uniform rod, and along a stretched spring; long gravity waves through a shallow canal. Several errors in previously published derivations are pointed out. A.

CAPILLARITY 532.6

532.68

6331. Exchange of liquid between paper pores. J. Weijdema. Letter in *Appl. sci. Res. A*, **4**, *No.* 3, 225–8 (1954).

It is shown that the expression used by Tollenaar [Abstr. 5336 (1954)] for the pressure existing in a liquid in a single capillary immediately above a branch capillary is incomplete. W. GOOD

MOLECULAR THEORY OF LIQUIDS 532.7

532.72

6332. On the physics of aqueous solutions. T. G. Owe Berg. *K. Tekn. Högsk. Avhandl. No.* 93, 39 *pp.* (1953).

Part of a general scheme of research on the corrosion of stainless steels in aqueous solutions. Viewing a solution as a new liquid structure of solvent and solute molecules a survey is made of the dissolution of metals in acid solutions, solubility of salts, conductivity and vapour pressure. The correctness of the conception is demonstrated for all the properties mentioned, comparison with experiment being made as often as possible. The whole forms an

illuminating outline of the subject and provides an excellent guide to research in the field. T. C. TOYE

532.72

6333. Maxwell effect in solutions of macromolecules: behaviour of the angle of extinction at very high velocity gradients. R. CERF. *J. Phys. Radium*, **15**, 145–51 (*March*, 1954) *In French.*

Experiment has shown that for a solution of deformable particles subjected to shearing stress, the angle of extinction approaches a limiting value χ_0 different from zero at high velocity gradients. In this paper a theory to explain this is presented. The particle in flow is regarded as having a static and dynamic anisotropy due to deformation and orientation by the flow. A simple relationship, connecting χ_0 and the internal viscosity of the particle, is obtained and applied to the results of Zvetkov and Frisman [*Acta Physicochim. U.R.S.S.*, **20**, 61 (1945)] on four polyisobutylenes, and Zvetkov and Petrova [*Zh. fiz. Khim.*, **23**, 368 (1949)] on a methyl polymethacrylate. Agreement is to within about 10%. Possible reasons for the divergence such as heating of the solutions and polydispersity are discussed. The possible applications of the theory, including those of distinguishing between rigid rod and spherical particles and of determining the internal viscosity of the particle, are mentioned. H. G. JERRARD

532.72

6334. On thermal diffusion in the liquid phase. J. JENNER AND G. THOMAES. Letter in *J. chem. Phys.*, **22**, 566–7 (*March*, 1954).

Measurements of the Soret coefficient (D'/D) for binary mixtures of the compounds CCl_4, CCl_3CH_3, $CCl_2(CH_3)_2$ and $C(CH_3)_4$. Most of the results can be explained in terms of a simple model. One that cannot is the fact that for the system CCl_3CH_3–$CCl_2(CH_3)_2$ the value of $10^4D'/D$ is found to increase from $0{\cdot}5 \pm 1$ at a mean temperature of $-2{\cdot}8$°C to 18 ± 1 at 25°C. R. O. DAVIES

532.72 : 532.517.4

6335. The dispersion of matter in turbulent flow through a pipe. G. TAYLOR. *Proc. Roy. Soc. A*, **223**, 446–68 (*May* 20, 1954).

The dispersion of soluble matter introduced into a slow stream of solvent in a capillary tube can be described by means of a virtual coefficient of diffusion [Abstr. 6530 (1953)] which represents the combined action of variation of velocity over the cross-section of the tube and molecular diffusion in a radial direction. The analogous problem of dispersion in turbulent flow can be solved in the same way. In that case the virtual coefficient of diffusion K is found to be $10{\cdot}1av_*$ or $K = 7{\cdot}14aU\sqrt{\gamma}$. Here a is the radius of the pipe, U is the mean flow velocity, γ is the resistance coefficient and v_* "friction velocity." Experiments are described in which brine was injected into a straight $\frac{3}{8}$ in. pipe and the conductivity recorded at a point downstream. The theoretical prediction was verified with both smooth and very rough pipes. A small amount of curvature was found to increase the dispersion greatly. When a fluid is forced into a pipe already full of another fluid with which it can mix, the interface spreads through a length S as it passes down the pipe. When the interface has moved through a distance X, theory leads to the formula $S^2 = 437aX(v_*/U)$. Good agreement is found when this prediction is compared with experiments made in long pipe-lines in America. A.

532.72 : 534.321.9

6336. On the question of the influence of ultrasonics on diffusion in liquids. K. ALTENBURG. *Z. phys. Chem.*, **202**, 460–73 (*Jan.*, 1954) *In German.*

A study shows that apart from secondary effects such as heating, the effect of ultrasonics is negligible T. C. TOYE

532.72 : 536.2

6337. Symmetry as a factor in finite difference approximations. C. M. FOWLER. *J. appl. Phys.*, **25**, 293 (*March*, 1954).

The effect of symmetry of the solutions to the finite difference diffusion equation upon the stability criterion is discussed. A simple example is included to illustrate the discussion. A.

532.73 : 535.435 : 535.51

6338. The magnitude of the optical anisotropy of the benzene and carbon disulphide molecules as determined by light scattering in solutions. M. F. VUKS AND V. I. ELFIMOV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 1, 29–32 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-175.

Using methods previously described [Abstr. 3188 (1953)], measurements are made on solutions up to 20% concentration in various solvents. The values calculated for the optical anisotropy agree with those for vapours, showing that in dilute solution the solute molecules are independent as in vapours; except for C_6H_6 in C_2H_5OH, where it is supposed that there is incomplete molecular solution. G. F. LOTHIAN

532.73 : 536.7

6339. Statistical thermodynamics of associated solutions. J. A. BARKER AND F. SMITH. *J. chem. Phys.*, **22**, 375–80 (*March*, 1954).

Thermodynamic data for the solutions chloroform + benzene, acetone + chloroform, ethanol + chloroform, ethanol + acetone, and ethanol + ether are discussed in the light of a model for associated solutions which has been described previously [Abstr. 65 (1953)]. The theory in its original form, previously found satisfactory for solutions of alcohols in non-polar solvents, proves satisfactory for the first two of these systems. To interpret the data for the remaining more complicated systems it is necessary to generalize the model to allow for interaction free energies which depend on temperature (presumably because of changes in vibration frequencies). The necessary generalization of the theory is described, and a consistent set of interactions for the ethanol systems is derived. The generalized theory should apply, with the limitations inherent in lattice theories, to most non-aqueous associated solutions. A.

532.731

6340. Mass transfer in fluid flow from a solid sphere. F. H. GARNER AND R. W. GRAFTON. *Proc. Roy. Soc. A*, **224**, 64–82 (*June* 9, 1954).

The general problem of mass transfer from a solid spherical surface in a fluid is discussed following

consideration of the flow patterns around a sphere and actual dissolution of solid spheres in a controlled stream of water. Experimental mass-transfer data for the dissolution of 0·5 in. benzoic acid spheres in a stream of water at room temperature are correlated by an equation. A.

532.74

6341. Molecular weight and internal pressure in organic liquids. S. PARTHASARATHY AND N. N. BAKHSHI. *J. sci. industr. Res.*, **12 B,** 455–7 (*Oct.*, 1953).

The relationship between molecular weight M and internal pressure P_i in liquids of homologous series may be represented by $P_i = A' + B'/M$ where A' and B' are constants. The relationship has been interpreted on the basis of intermolecular forces. A.

532.74 : 534.222

6342. The dispersion of sound-velocity, the temperature coefficient, the compressibility and the apparent molal compressibility of $MgSO_4$ solutions. N. S. TASKÖPRÜLÜ. *Rev. Fac. Sci. Univ. Istanbul A*, **18,** 352–68 (*Oct.*, 1953).

The anomalous absorption of sound in a $MgSO_4$ solution has been explained by Liebermann [Abstr. 1591 (1950)] assuming a relation mechanism connected with the ionic equilibrium of the solution, and the relaxation frequency should be proportional to the concentration; the value of the sound dispersion which is connected with this anomalous absorption should be proportional to the 3/2 power of the concentration. For a 1 M solution the velocities for 5 and 15 Mc/s were measured with the double cell method. The relative dispersion was found, $D = (v_{15} - v_5)/v_5 = (0{\cdot}37 \pm 0{\cdot}15) \times 10^{-3}$, a value which is 4·9% of the value calculated from the assumptions of Liebermann. At 20°C the temperature coefficient of the velocity in a 1 M $MgSO_4$ solution was found to be 2·0 m/sec per degree. The velocity, the adiabatic compressibility and the apparent molal compressibility are given for a 1 M $MgSO_4$ solution at 25°C and it could be shown that the apparent molal compressibility increases linearly with the square root of the concentration up to 2 M. A.

532.74 : 534.222

6343. Dispersion of sound velocity in certain organic liquids. I. L. FABELINSKIĬ AND O. A. SHUSTIN. *Dokl. Akad. Nauk SSSR*, **92,** *No.* 2, 285–8 (1953) *In Russian* English translation, *U.S. National Sci. Found. NSF-tr*-194.

The velocity of sound at 10 000 Mc/s was measured in benzene, toluene and CCl_4 by finding the frequency shift of the Raleigh lines. The results (together with the percentage positive dispersion with respect to the velocity at about 50 Mc/s) were: benzene, 1470 ± 26 m/s (10%); toluene, 1297 ± 20 m/s (0%); CCl_4, about 1080 m/s (about 16%). If it is assumed that all the excess absorption at ultrasonic frequencies is due to a single relaxation process and that the dispersion is complete at 10 000 Mc/s, then the above figures imply relaxation times of $2{\cdot}4 \times 10^{-10}$ sec for benzene and $6{\cdot}7 \times 10^{-11}$ sec for CCl_4 at 20°C. It is suggested that the relaxation time for toluene is also $\sim 10^{-10}$ sec. The lower excess absorption in this substance would then yield a dispersion of 0·1%—which is too small to detect and therefore does n contradict the above result. In support of this it noted that toluene exhibits a sharply defined fi structure and that this would not be possible if α/α remained constant up to 10 000 Mc/s. R. O. DAVI

532.74 : 534.22

6344. Ultrasonic velocities in binary mixture C. G. BALACHANDRAN. *J. Indian Inst. Sci. A*, 3 10–18 (*Jan.*, 1954).

Ultrasonic velocities and their variation with co centration have been measured for five binary mi tures, e.g. toluene–heptane, pyridine–acetic aci pyridine–*n*-butyric acid, nitrobenzene–*n*-butyl alcoh and methyl alcohol–benzene. From the observe value of the velocity, adiabatic compressibility wa calculated for each mixture. The effect of compoun formation and association on the compressibilities c these mixtures is examined. A

MECHANICS OF GASES 533

533.15 : 539.155.2

6345. Investigation of the performance of therma diffusion column, B. N. SRIVASTAVA AND R. C SRIVASTAVA. *Physica*, **20,** 237–42 (*April*, 1954).

The theory of the thermal diffusion column as developed by Furry and Jones for the cylindrical case has been extended to take into account the variation of the thermal diffusion constant α with temperature in the usual form $\alpha = A - B'/T$. Expressions have been obtained for the column constant H which are shown to agree closely with the experimental data of Nier on methane. The exact evaluation of the asymmetry term K_p and of the thermal diffusion constant α from the observations on the column are discussed. A.

533.2

6346. The rapid expansion of compressed gases behind a piston, the effect of molecular interaction. I. Theory of the experiment. Z. I. SLAWSKY, A. MICHELS AND S. J. JACOBS. *Physica*, **20,** 210–22 (*April*, 1954).

It is shown that thermodynamical properties obtained from experimental p–v–T data suffice to calculate the value of this effect. As an example the expansion of nitrogen has been calculated. The results show a marked difference from those derived under the assumption of the gas being ideal or consisting of hard sphere molecules. On the other hand it is shown that thermodynamical properties can be calculated if the expansion rate is measured with sufficient accuracy. A.

533.2

6347. The rapid expansion of compressed gases behind a piston, the effect of molecular interaction. II. An apparatus for studying transient expansions. A. MICHELS, S. J. JACOBS AND Z. I. SLAWSKY. *Physica*, **20,** 223–36 (*April*, 1954).

The apparatus used for studying the rapid one-dimensional expansion of a gas behind a piston is

described. Gas expansion can be studied in this apparatus at initial pressures as high as 3000 atm. Displacement–time curves for the piston motion are accurately measured. Both pressure in the gas behind the piston and velocity can be determined by differentiation of the data. Measuring equipment has been developed which can establish several datum points on the displacement–time curve to a precision of 20 μ for distance and 1 μsec for time. The apparatus has been tested with nitrogen over a range of initial pressures from 700 to 2500 atm. A.

533.5

6348. A metal vacuum valve. G. M. VAN KOPPEN. Letter in *Appl. sci. Res. B*, **3**, *No.* 2, 141 (1953).

A three-way valve, in which all seals are made of rubber O-rings. A method of connecting to a backing pump, an electron microscope and an oil diffusion pump is given. The backing pump is automatically switched on and off by actuation of the valve. The O-rings are good for > 5000 revolutions. G. WITTENBERG

533.5

6349. On a new device for evacuation in high vacuum. O. TSUKAKOSHI. *J. Sci. Res. Inst.* [*Tokyo*] **47**, 133–48 (*Dec.*, 1953).

A glass bulb of 15 cm dia., furnished with a barium source and a hot cathode Philips gauge type discharge tube, was found to serve as an excellent high vacuum pump for oxygen, hydrogen, carbon dioxide and water vapour. Pumping speed of about 80 l/sec at 3×10^{-7} mm Hg was recorded for oxygen, 8 l/sec at $2{\cdot}5\times10^{-6}$ mm Hg for hydrogen, 50 l/sec at $1{\cdot}2\times10^{-7}$ mm Hg for carbon dioxide and 26 l/sec at $2{\cdot}5\times10^{-7}$ mm Hg for water vapour. A.

533.5

6350. Ultra-high vacuum. II. Limiting factors on the attainment of very low pressures. D. ALPERT AND R. S. BURITZ. *J. appl. Phys.*, **25**, 202–9 (*Feb.*, 1954).

For Pt I, see Abstr. 8274 (1953). Recently developed ultra-high vacuum techniques, with which it is possible to achieve working pressures of 10^{-10} mm Hg or less, have made feasible the investigation of a number of physical processes occurring at very low pressures. The Bayard–Alpert ionization gauge has been calibrated over its useful range and some of the important limitations on the production and measurement of ultra-high vacuum have been determined. It has been shown that an ultimate limitation on the achievement of very low pressures in glass systems is caused by the diffusion of atmospheric helium through the walls of the system. A simplified omegatron has been developed for the measurement of the partial pressures of residual gases in a highly evacuated system. A.

533.5

6351. Experimental studies on the force exerted on a disc placed in a flow of rarefied gas. Y. SUGIURA. *J. Phys. Soc. Japan*, **9**, 244–8 (*March–April*, 1954).

As a basic study of the meter described in Abstr. 2253 (1953) the force was measured under various conditions, namely, the pressure of the flowing gas, the diameter of the disk, and the position of the disk along the radius of the pipe being varied. The results of the measurement are shown in figures and expressed by empirical formula. The results here obtained are in agreement with theoretical expectations for Knudsen and Poiseuille flow. In the Knudsen flow, it is confirmed that the asumption of diffuse reflection of molecules on the disk is adequate. In the intermediate flow case between Knudsen and Poiseuille flow, the force shows an anomalous behaviour which seems to have some correlation with the phenomena observed by Knudsen and others. A.

533.5 : 531.788.7

6352. A demountable all metal hot-cathode vacuum ionisation gauge. P. K. DUTT. *Indian J. Phys.*, **28**, 1–8 (*Jan.*, 1954).

A gauge has been constructed whose filament can be changed any number of times without a change in the operational characteristics. The characteristic curves of the gauge are given. Some points towards the constructional improvements are discussed which might give better sensitivity. A.

533.5 : 541.127

6353. On the rate of decomposition of diffusion pump oil. C. HAYASHI. *J. Phys. Soc. Japan*, **9**, 287–90 (*March–April*, 1954).

The rate of decomposition of diffusion pump oil under working conditions seems to be an important quantity in vacuum technique. The following experiment was carried out to give an answer to the problems of whether various metals catalyse the decomposition of diffusion pump oil and the gaseous components of the decomposition products limit the ultimate vacuum of an oil diffusion pump. The quantity of non-condensing gaseous components of the decomposition products accumulated in a vessel in a given time was measured for the two typical oils, *n*-dioctylhexahydrophthalate and silicone DC-703, using a flowmeter designed by R. Ueda. The results show that the rate of decomposition is of the order of 10^{-6} litre micron Hg per sec per square centimetre of surface for both oils. The ester slightly suffered from catalytic decomposition, though the silicone showed none. The measured rate of decomposition is so low that it will never contribute more than 1×10^{-5} micron Hg to the ultimate vacuum of an oil diffusion pump. A.

533.6.011.4

6354. On the subsonic flow behind the bow wave of a finite wedge. H. OGUCHI. *J. Phys. Soc. Japan*, **9**, 249–55 (*March–April*, 1954).

Recently Tamada analysed the subsonic flow over a finite wedge behind the attached shock wave by solving a linearized potential equation [Abstr. 3930 (1953)]. When the shock is not strong, the linearized potential equation may be applied with good approximation. But, when the shock is strong, the flow field behind the shock should be treated as an anisentropic and rotational one. For such an anisentropic flow Lighthill's equation will be more suitable. By the use of Lighthill's equation an analytical expression of the problem was obtained in a form analogous to Tamada's. Also the case for a finite wedge whose surface deviates slightly from a straight line was analysed. A.

533.6.08 : 534.21

6355. Measurement of flow velocities in wind tunnels by acoustic methods. O. K. MAWARDI. *Acustica*, **4**, *No.* 1, 114–16 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. An acoustic method is proposed for the evaluation of the average flow velocity in wind tunnels. The method is based on an estimate of the effect of a mean velocity of the medium on the time of arrival of a sound signal. The effect of the boundary layer on the propagation of sound waves is discussed. The results obtained by the method are expected to yield a reasonably good accuracy. A.

533.6.69

6356. The lift on the symmetrical Joukowski aerofoil in a stream bounded by a plane wall. H. FUJIKAWA. *J. Phys. Soc. Japan*, **9**, 233–9 (*March–April*, 1954).

533.6.69

6357. Note on the lift acting on a circular-arc aerofoil in a stream bounded by a plane wall. H. FUJIKAWA. *J. Phys. Soc. Japan*, **9**, 240–3 (*March–April*, 1954).

MOLECULAR THEORY OF GASES 533.7

533.7

6358. The second virial coefficient at very low temperatures. K. HIROIKE. Letter in *Progr. theor. Phys.*, **10**, 575–7 (*Nov.*, 1953).

Starting from the expression for B in terms of the phase shifts, an expression is obtained which agrees with Green's [Abstr. 2258 (1953)] except for terms coming from the bound states of two molecules.

E. H. SONDHEIMER

533.7

6359. The effect of channel holes on the force exerted by effusing vapors. R. D. FREEMAN AND A. W. SEARCY. Letter in *J. chem. Phys.*, **22**, 762–3 (*April*, 1954).

Gives the result of calculations of the recoil force caused by vapours effusing from a small hole in a Knudsen cell, as a function of L/r, where L is the length of the hole and r its radius. For comparison are listed the probabilities that a molecule entering one end of a hole will escape from the other.

L. G. CARPENTER

533.7

6360. A model for collision processes in gases. I. Small amplitude processes in charged and neutral one-component systems. P. L. BHATNAGAR, E. P. GROSS AND M. KROOK. *Phys. Rev.*, **94**, 511–25 (*May* 1, 1954).

A kinetic-theory approach to collision processes in ionized and neutral gases is presented. This approach is adequate for the unified treatment of the dynamic properties of gases over a continuous range of pressures from the Knudsen limit to the high-pressure limit where the aerodynamic equations are valid. It is also possible to satisfy the correct microscopic boundary conditions. The method consists in altering the collision terms in the Boltzmann equation. The modified collision terms are constructed so that each collision conserves particle number, momentum and energy; other characteristics such as persistence of velocities and angular dependence may be included. The technique for a simple model involving the assumption of a collision time independent of velocity is illustrated; this model is applied to the study of small-amplitude oscillations of one-component ionized and neutral gases. The initial value problem for unbounded space is solved by performing a Fourier transformation on the space variables and a Laplace transformation on the time variable. For uncharged gases there results the correct adiabatic limiting law for sound-wave propagation at high pressures and, in addition, one obtains a theory of absorption and dispersion of sound for arbitrary pressures. For ionized gases the difference in the nature of the organization in the low-pressure plasma oscillations and in high-pressure sound-type oscillations is studied. Two important cases are distinguished. If the wavelength of the oscillations are long compared to either the Debye length or the mean free path, a small change in frequency is obtained as the collision frequency varies from zero to infinity. The accompanying absorption is small; it reaches its maximum value when the collision frequency equals the plasma frequency. The second case refers to waves shorter than both the Debye length and the mean free path; these waves are characterized by a very heavy absorption. A

533.72 : 536.2

6361. On the temperature jump in a rarefied gas. P. WELANDER. *Ark. Fys.*, **7**, *Paper* 44, 507–53 (1954).

A theoretical investigation is made of the condition in a rarefied monatomic gas having heat exchange with an adjacent wall. The calculations have been carried out on the assumption that the rate of change of the molecular distribution function owing to the intermolecular collisions is proportional to the deviation from the Maxwellian state, and that the gas molecules which impinge on the wall are reflected back in Maxwellian distribution. The resulting temperature distribution in the gas shows an infinite gradient at the wall. The temperature jump differs from that given previously by Smoluchowski and others in that the factor $(2 - a)/a$ is replaced by $(2 - ka)/a$, where k is a constant. Its value is calculated as 0·827. It may be expected that the result apply quite well for polyatomic gases, also. A

533.72 : 536.2

6362. Heat conduction in a rarefied gas: the cylindrically symmetrical case. P. WELANDER. *Ark. Fys.* **7**, *Paper* 45, 555–64 (1954).

The effect of the temperature jump value previously calculated (preceding abstract) is investigated.

VIBRATIONS . ACOUSTICS 534

534.011/.012 : 532.59

Elementary derivation of equations for wave speeds. *See Abstr.* 6330

534.21

6363. Theory of the visualization of ultrasonic waves. I. Theory of the schlieren method for visualizing ultrasonic waves. O. NOMOTO. *J. Phys. Soc. Japan*, **9**, 267–78 (*March–April*, 1954).

Intensity distribution of light in the image of progressive ultrasonic waves obtained by the schlieren method with stroboscopic illumination has been computed by the vector method. Pure phase-lattice is assumed in the plane of emergence of light out of the ultrasonic beam and the plane of focusing is assumed to be this plane. Several cases are to be distinguished according to the orders of light removed in obtaining the image: (*a*) When the ultrasonic image is obtained by removing zero-order light, the visibility is good for small values of v, the amplitude of variation of the phase angle in the phase-lattice—corrugated wave—of light produced in the plane of emergence of light from the ultrasonic wave. The visibility vanishes, however, at zeros of the Bessel function $J_0(v)$ ($v = 2{\cdot}40, 5{\cdot}52, \ldots$); (*b*) When the image is obtained by removing one of the two first-order spectra, the visibility is zero for $v = 0$, and for the other values of zeros of $J_1(v)$ ($v = 3{\cdot}83, \ldots$), having maximum between two neighbouring zeros. (*c*) The visibility of the image obtained by removing the zero-order spectrum and one of the first-order spectra is always better than that of the image obtained in case (*b*) and also better than the image obtained in case (*a*) except for small values of v ($v \leqslant 1$). The visibility in the case (*c*) is comparatively insensitive to the values of v for wide range of v, being better than 75% for $v = 1 \sim 6$. (*d*) The visibility of the image obtained by removing one of the first-order spectra and part of the light of the zero order is improved in the region of small values of v as compared with the case (*c*), the visibility for greater values of v not much decreasing. For example, the visibility of the image obtained by removing 97·75% (in intensity) of the zero-order light and one of the two first orders is more than 95% in the range $v = 0{\cdot}2 \sim 2$ and not less than 70% in the range $v = 0{\cdot}1 \sim 6$. In all cases, the ultrasonic images show fine structures as the value of v increases. A.

534.21

6364. Theory of the visualization of ultrasonic waves. II. Theory of the phase-shift method for visualizing ultrasonic waves. O. NOMOTO. *J. Phys. Soc. Japan*, **9**, 279–86 (*March–April*, 1954).

The phase-shift method applied to the zero-order spectrum is particularly suitable for comparatively small values of $v (v < 2\pi/3)$, where v means the amplitude of variation of the phase angle in the phase-lattice (corrugated wave) of light produced in the plane of emergence from the ultrasonic wave. Good visibility is to be obtained in the range of $v < 2\pi/3$, with a phase-shift of $\delta = \pi/2$ and transmission unity ($g = 1$), so long as the value of v is not so small. For small values of v the visibility is to be improved by reducing the transmission g. For values of $v \geqslant 2\pi$, the phase-shift of $\delta = \pi$ is more suitable though in this case more satisfactory results are to be obtained by the schlieren method, in which the first-order spectrum and the zero-order (or part of it) are removed. For values of v corresponding to the zero-point of $J_0(v)$, the phase-shift method gives, naturally, no image. A.

534.21 : 534.23/.24 : 534.26

6365. Propagation, interference, reflection, absorption and scattering, of sound and ultrasonic waves, made visible by the schlieren method. F. CANAC. *Acustica*, **4**, *No.* 2, 320–8 (1954) *In French.*

Paper given at the Congress of The International Commission of Acoustics, 1953. Observation by strioscope allows study of these phenomena without disturbance. Usually frequencies of 69 and 23 kc/s have been used but it is possible to go down to 4 kc/s. Applications in architectural acoustics are described (rôle of balconies, circular galleries, cavities in the ceiling, etc.). By using ultrasonic waves reflected between two parallel mirrors the acoustic analogue of the electromagnetic waveguide has been realized. A.

534.21

6366. The field and radiation impedance of mechanical radiators on the free surface of a semi-infinite isotropic solid. G. F. MILLER AND H. PURSEY. *Proc. Roy. Soc. A*, **223**, 521–41 (*May* 20, 1954).

Definite integral representations are obtained for the field at an arbitrary point in a semi-infinite solid, due to stresses on the free surface which vary sinusoidally with time. From these integrals, asymptotic expressions have been obtained for the field at infinity in the solid, and polar diagrams showing the variation of field strength with direction are given. Integrals are also found for the mean displacement over the externally stressed region of the surface, and these have been evaluated numerically in a number of cases to obtain the radiation impedance of the sources represented by such stress systems. A.

534.21 : 539.215.9

6367. Investigation of the acoustic behaviour of powders under shear-wave treatment. M.-L. EXNER, W. GÜTH AND F. IMMER. *Acustica*, **4**, *No.* 2, 350–8 (1954) *In German.*

A vibrometer is described suitable for measuring the mechanical impedance in such a case in the range 100 to 4000 c/s. The acoustical properties of the medium are investigated from impedance curves, obtained under various conditions, characteristic of the structure. With the aid of a simple model for the structure the meaning of the results obtained is elucidated. It appears that in sand under certain circumstances, just as in solid blocks of material, compressional as well as shear waves are set up. Only the latter are studied in this paper. A.

534.213

6368. A method of measuring discontinuity effects in ducts. W. K. R. LIPPERT. *Acustica*, **4**, *No.* 2, 307–12 (1954).

A method of measuring the sound reflection and transmission at discontinuities in ducts (acoustical filters) is described. The experimental technique uses a non-reflecting terminal and the same probe microphone for exploring the sound field on each side of the discontinuity. The theory of the method, which is considered to be useful for obtaining complete and accurate results in fundamental work, is given in detail and it is shown how the characteristic reflection and transmission factors and the equivalent impedance

matrix are derived from measurable quantities and the simplifications available in symmetrical or loss-free cases. A.

534.213

6369. The measurement of sound reflection and transmission at right-angled bends in rectangular tubes. W. K. R. LIPPERT. *Acustica*, **4**, *No.* 2, 313–19 (1954).

Equipment for measuring the sound reflection and transmission at discontinuities in ducts is described. It has been used for measurements of the sound propagation along right-angled bends in rectangular tubes. The characteristic reflection and transmission factors and the impedance matrix of the equivalent four-terminal electrical circuit are derived from the measurements for different frequencies and compared with the zero-order approximation derived from theoretical wave acoustics. Results are given also for a particular asymmetrical discontinuity. The general method and simplifications of the technique for loss-free and symmetrical discontinuities are confirmed. A.

534.213

6370. An acoustic wave guide lens for use in liquids. H. NÖDTVEDT. *Acustica*, **4**, *No.* 1, 202–5 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. A short treatment of sound propagation between parallel, completely resilient plates is given. The phase conditions inherent in a medium of this kind make it possible to construct acoustic lenses in liquids. Measurements of the frequency characteristics of a set of plates show a high-pass filter response, in agreement with theory. The data for a lens to be used in water at 30 kc/s are given, and its directive properties presented. A.

534.213 : 539.32

The ultrasonic measurement of elastic and anelastic constants of solids. *See Abstr.* 6940

534.222.1 : 539.32

6371. Sound velocity and elastic constants in heterogeneous substances. H. MANDEL. *Acustica*, **4**, *No.* 2, 333–40 (1954) *In German.*

The velocity of propagation of longitudinal and transverse waves in solid bodies is measured by a pulse method, using an ultrasonic source. A comparison is made of the times of travel of the pulse in the test piece and in water respectively. The material constants are derived from the velocities. Velocity measurements in heterogeneous substances are explained in terms of simple models and the relevant equations are established. Applications to alloys are discussed. A.

534.222.2

6372. A contribution to the theory of elastic waves produced by shock. J. VANĚK. *Czech. J. Phys.*, **3**, *No.* 2, 97–119 (1953).

The paper deals with the investigation of elastic waves in an infinite homogeneous, isotropic and perfectly elastic medium produced by a spherical source on the assumption that the spheroidally distributed stress on the surface of the source is an arbitrary function of time. The case of an explosive source leading to an exciting function of the shock type is investigated and discussed in detail. For waves having orders $n = 0$ and $n = 1$ the depende of the maximum amplitude on the distance is det mined. The distance up to which the manner propagation of the considered waves is affected the mechanism of their generation is also determin

534.22

6373. On the propagation and structure of a bl wave. II. A. SAKURAI. *J. Phys. Soc. Japan*, **9**, 256 (*March–April*, 1954).

For Pt I, see Abstr. 170 (1954). The secc approximation is discussed. The solution for $\gamma =$ is obtained by a numerical method, using the resu of the first approximation obtained in Pt I. By of this solution, *U-R* curves, distance-time curves a the changing feature of distributions of veloc pressure and density behind the shock front are d cussed. Further, the approximate solution of equation is discussed by a refinement of the W method due to Imai.

534.22

6374. The reflection of shock waves from a bl wedge. V. H. BLACKMAN AND D. K. WEIMER. *Ph Rev.*, **94**, 508–10 (*May* 1, 1954).

The pseudostationary field resulting from the hea on reflection of a shock wave at a corner of an $(\pi - \delta)$, where δ is small, has been investigated w the shock tube and interferometer. The wave co figuration and the pressure along the wall are co pared with the theory developed by Lighthill. T results are in qualitative agreement and indicate th the theory is correct for vanishingly small δ. T density field is also given.

534.

6375. Ultrasonic absorption coefficient in liquids the thermal method. S. PARTHASARATHY, P. MAHENDROO AND S. S. MATHUR. *J. sci. industr. Re* **12 B**, 457–8 (*Oct.*, 1953).

Ultrasonic absorption coefficients have be measured in six organic liquids using the meth described in Abstr. 6558 (1953). The results are good agreement with the values obtained by oth methods.

534.23 : 534.2

6376. A study of ultrasonics by magnetostricti vibrators. Y. TAKESADA. *Mem. Coll. Sci. Un Kyoto A*, **26**, 31–43 (*Oct.*, 1950).

Experiments with vibrators of different types show that the efficiency is greatly improved if thin no magnetic plates are inserted between those of t ferromagnetic substance. The absorption coefficie in water is shown by calculation to be inverse proportional to the number density of air bubbles. T. C. TO

534.231 : 534.321

6377. Experimental study of the field of focusi ultrasonic transducers. J. P. PAHUD. *Acustica*, *No.* 1, 205–7 (1954) *In French.*

Paper given at the Congress of the Internation Commission of Acoustics, Netherlands, 1953. U of a thermoelectric probe to study the field radiate in water at 0·5, 1, 2, 3 and 4 Mc/s by ultrason transducers with biconical focusing horns.

534.231 : 535.32

6378. A simple method for photographing the sound ressure distribution in a stationary ultrasonic wave. . P. LOEBER AND E. A. HIEDEMANN. Letter in . *Acoust. Soc. Amer.*, **26**, 257 (*March*, 1954).

The method previously described [see Abstr. 5377 1954)], has been modified by placing a slit in the ath of the light beam between the sound wave and he film. By moving the film in the same direction as he cell containing the stationary sound wave, pressure radient variations in the sound wave are recorded on he film. G. F. HODSMAN

534.231.3

6379. Remarks on the definition of vectorial sound conduction values for acoustical impedances and acoustic elements. W. WILLMS. *Acustica*, **4**, *No.* 1, 133–6 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The admittance vector and an impedance vector may be introduced in the sound field. But, if for the vector components the relation of reciprocity $z = 1/y$ is to be maintained, only one vector, preferably the admittance vector, may be used. It is proposed to use in an acoustic waveguide a mean square surface value of particle velocity and pressure. The analogy between acoustic and electric impedance elements needs special definitions and rules. On the contrary the matrix gives all the information required and the two analogous circuits are easily derived. A.

534.232

6380. Ultrasonic generator for gaseous media. K. BRÜCKMANN. *Chem.-Ingen.-Tech.*, **25**, 492–6 (*Aug.–Sept.*, 1953) *In German.*

A new generator of both the sound and ultrasonic waves is described; it is driven by a gas current and can be used in the range of 5–500 kc/s. A membrane separates the generating gas current from the sonic field, thus causing a loss of 20% of sonic energy. The generator can be used as an ultrasonic interferometer for determining the wavelength or frequency of the sound wave. The directed waves can be focused at will by means of a built-in membrane. F. LACHMAN

534.232

6381. Useful absolute efficiencies of typical loudspeaker systems. R. K. VEPA AND N. K. TRIVEDI. *Acustica*, **4**, *No.* 2, 329–32 (1954).

Several types of efficiencies of loudspeakers are in current usage and which of them is specified in any particular instance is not usually made explicit. A new quantity, termed the "useful absolute efficiency," is proposed as an index of practical loudspeaker performance. A set-up to measure such an efficiency is described and the results obtained with representative groups of speakers are discussed. It is shown that the useful efficiencies of direct radiator speakers are less than 1%, of straight horn systems about 2% and of re-entrant horns of the order of 10%. A.

534.232

6382. The Élipson shell. A transformer for acoustic radiation. R. LEHMANN. *Acustica*, **4**, *No.* 1, 84–6 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. After emphasizing the difficulties of using an ordinary loudspeaker under optimum conditions, the author describes a new type, called "shell," which gives an improvement over the commonly used transducers. The shell consists of two distinct parts, reflector and resonant enclosure each of which is described as to its construction and acoustic properties. Data are given. A.

534.232

6383. Absolute calibration of hydrophones by various methods in the frequency range 0·1–15 kc/s. K. TAMM. *Acustica*, **4**, *No.* 1, 128–31 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Three types of piezoelectric pressure-sensitive hydrophones suitable for calibration have been described, a diaphragm type (ADP-crystals), an oil capsule type (LS-crystals) and a tourmaline receiver. The calibration methods: pistonphone (130 c/s), reciprocity cavity (0·2–3 kc/s), field calibration by Rayleigh disk (10–15 kc/s) result in a frequency-independent sensitivity of the oil capsule type of 10^{-4} V/(N/m^2). An electrostatic relative calibration (1–20 kc/s) completes the frequency range. A.

534.232

6384. Use of temperature- and time-stabilized barium titanate ceramics in transducers, mechanical wave transmission systems and force measurements. W. P. MASON. *Acustica*, **4**, *No.* 1, 200–2 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Barium titanate ceramics can be temperature-stabilized by introducing $PbTiO_3$ and $CaTiO_3$. Two stable compositions have high electrical and mechanical "Q's." Ageing occurs because of domain wall motions induced by residual stress. By heating to a temperature under the Curie point, faster ageing occurs. External stress causes ageing and high stresses completely depolarize the ceramic, producing a charge one-third that for single domain crystals. A rate theory accounts for the results. A.

534.232 : 534.321.9

6385. Ultrasonic electro-acoustics. General review. G. BRADFIELD. *Acustica*, **4**, *No.* 1, 171–80 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953.

534.232 : 534.321.9

6386. Experiments on some electrodynamic ultrasonic vibrators. A. BARONE AND A. GIACOMINI. *Acustica*, **4**, *No.* 1, 182–4 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Some types of ultrasonic vibrators are described. These are made of solids of various forms which are set in vibration by the electrodynamic effect. Solids made of insulating materials are partially metallized so that they can be set in vibration. The use of such vibrators to measure elastic constants is proposed. The same vibrators may serve as ultrasonic sources for the laboratory. A.

534.232 : 534.321.9

6387. Experiments on a tuned transducer for the ultrasonic range. A. GIACOMINI AND G. POIANI. *Acustica*, **4**, *No.* 1, 188–9 (1954).

Paper given at the Congress of the International

Commission of Acoustics, Netherlands, 1953. Experiments on ultrasonic transducers formed of a piezoelectric element of barium titanate between two rods of aluminium are described. These transducers, used as microphones in the air, have a good sensitivity (70 mV/dN.m^{-2}) and a Q of 2500. The same transducers can be used as ultrasonic sources of comparatively high intensity. A.

534.232 : 534.321.9

6388. The design of low frequency ultrasonic transducer housings. P. HATFIELD. *Acustica*, **4**, *No.* 1, 193–5 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Ultrasonic techniques have been developed for detecting internal voids and measuring the thickness of rubber products. Low frequency ultrasonic waves from 50 to 500 kc/s have been used because of the relatively high absorption of ultrasonic waves in rubber. This paper gives practical details of transducers and their associated water-tight housings, including suitable rubbers for acoustically matching the transducer into a liquid medium, and a simple electrical network for electrically matching the transducer output into an amplifier. It also describes a transmitting and receiving crystal mounted in a common housing for use when only one surface is available. A.

534.232 : 534.321.9 : 615.825.65

6389. Acoustic performance determination during therapeutic treatment with ultrasonic apparatus. W. GÜTTNER. *Acustica*, **4**, *No.* 1, 190–3 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Whereas the wave-resistance of the human body when irradiated is constant and equal to that of water the effective radiating area of a transducer (at best lithium sulphate) in ultrasonic therapy may change during the treatment, so that its radiation resistance ought to be measured while it is in operation. When this is done, changes in this factor can be used to warn the therapeutist to take care that the radiating surface under the clamp has not changed. A.

534.232 : 534.6 : 621.317.353.1 : 621.395.623.7

6390. Measurements of non-linear distortion in loudspeakers. F. INGERSLEV. *Acustica*, **4**, *No.* 1, 74–7 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. A new method for the determination of nonlinear distortion in a loudspeaker based on measurement of the sound pressures of the new tones generated by the loudspeaker when driven by a stimulus of two tones of sinusoidal waveform is described. A.

534.232 : 578.088.2

6391. On a type of ultrasonic transducer suited for use on biological material. A. BARONE. *R.C. Ist. Super. Sanità*, **16**, *Pt I–II–III*, 39–44 (1953) *In Italian.*

In the device described a beam of plane waves is transformed into a field of cylindrical waves by means of a conical reflector. The body of the tube containing the biological material suspended in liquid, which is to be subjected to the ultrasonic waves, is placed along the axis of the apparatus. Som observations on the qualitative characteristics of t system are made.

534.25 : 534.32

6392. Experimental study of an ultrasonic transduc at oblique incidence. G. MALHERBE. *Acustica*, *No.* 1, 198–9 (1954) *In French.*

Paper given at the Congress of the Internation Commission of Acoustics, Netherlands, 1953. the ultrasonic testing of materials (particularly in t testing of soldered joints), it is desirable to irradia the part at an oblique incidence. Refraction at t entrance produces propagation of different types waves (transverse, longitudinal, superficial) in differe directions. Study of the distribution of energy betwe the various types of waves in terms of the angle incidence. Description of the experimental device an results obtained with various kinds of steel.

534.3 : 534.4

6393. The characterization of sound objects by us of the level recorder in musical acoustics. A. MOLE *Acustica*, **4**, *No.* 1, 241–4 (1954).

Paper given at the Congress of the Internationa Commission of Acoustics, Netherlands, 1953. musical sound is a quasi-periodic phenomenon, be expressed by a tri-dimensional representation i terms of level, pitch, duration, the perception of whic follows Fechner's law. The logarithmic bathymete only gives recordings of the level-time plane, unde various restrictions, so a method of classification c the signals on punched cards has been develope which can be applied either to noises or musica sounds. A

534.3 : 612.8

6394. Audibility of nonlinear distortion in the trans mission of the sounds of instruments. R. FELDTKELLER *Acustica*, **4**, *No.* 1, 70–2 (1954) *In German.*

Paper given at the Congress of the Internationa Commission of Acoustics, Netherlands, 1953. A timbre poor in overtones is much more sensitive t nonlinear distortion than one rich in overtones. The causes and the extent of this difference are discussed. A

534.321.9

6395. Some industrial applications of ultrasonics R. W. SAMSEL, G. E. HENRY AND R. O. FEHR *Acustica*, **4**, *No.* 1, 207–11 (1954).

Paper given at the Congress of the Internationa Commission of Acoustics, Netherlands, 1953. To-day cleaning of small metal parts is the most important application of high power ultrasonics in industry. Studies have been made to determine the requirements of intensity and exposure time for cleaning operations. An adequate transducer has been built and installed in a factory. A probe, consisting of a thermistor imbedded in a small plastic sphere, has been developed for measuring intensity. A.

534.323

6396. On the audibility of linear distortion for natural sounds. N. MAYER. *Funk u. Ton*, **8**, 1–6 (*Jan.*, 1954) *In German.*

Describes a determination of the minimum perceptible variations of intensity at various frequencies

the range 75 c/s to 9600 c/s, using different musical sounds [klangbild], (1) piano, (2) cembalo and flute, (3) cembalo alone and (4) orchestra. The various sounds were reproduced by a loudspeaker in an anechoic room with the observer under test 2 metres away. In all cases, at mean and high frequencies (i.e. from 500 to 9600 c/s), the least perceptible variation from normal was about 4 db. This minimum detectable variation increased to 10 db as the frequency was lowered from about 500 c/s to 75 c/s.

A. B. WOOD

534.39

6397. Acoustic radiation pressure on a prolate spheroid. J. AWATANI. *J. Inst. Elect. Commun. Engrs Japan*, **35**, 311–15 (*July*, 1952) *In Japanese.*

A mathematical investigation of the pressure exerted on a spheroid in a plane sound field. The sound diffraction and inertia effect of the spheroid are discussed and the radiation pressure deduced. When the dimensions of the spheroid are less than the wavelength, the pressure on it is very much greater than that on the disk or sphere having the same cross-section as that of the spheroid. For a spheroid with an axes ratio of 4 : 1 the radiation pressure is about 250 times that on the corresponding disk in the progressive-wave field and about 13 times that in the standing-wave field. Radiation pressures are calculated for spheroids with axes ratios of 1, 2, 3 and 4, both for progressive-wave and for standing-wave fields, the results being tabulated in terms of the pressure on the corresponding disk.

A. WILKINSON

534.44 : 534.32

6398. A sound reversal technique applied to the study of tone quality. W. H. GEORGE. *Acustica*, **4**, *No.* 1, 224–5 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Reversal of magnetic-tape sound-recordings is used to investigate the influence upon tone-quality of growth and decay of sounds. If the instantaneous overtone structure (as technically defined in the paper) changes with time, reversal of the sound profoundly alters the tone-quality. The idea of tone-quality as the overtone structure of the "steady state" of a note modified by "transients," is abandoned for the idea of tone-quality as a "pattern property." A.

534.6

6399. Acoustic measurements. General Review. L. L. BERANEK. *Acustica*, **4**, *No.* 1, 92–6 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953.

534.61

6400. The measurement of phase and intensity in sonic and ultrasonic fields. L. E. LAWLEY AND E. G. RICHARDSON. *Acustica*, **4**, *No.* 1, 196–7 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. A method of recording the phase of a received signal in a system of plane progressive waves in relation to another signal of fixed phase is described, with the primary object of measuring changes in the velocity of sound, hence of the composition, of a mixture of gases. Recent work in ultrasonics is reported in which hot-wires and thermistors have been used for intensity measurements in stationary waves or to measure streaming velocities near a quartz generator, to show the usefulness of these devices. A.

534.612.2

6401. The measurement of acoustic pressures in moving air streams. R. W. LEONARD. *Acustica*, **4**, *No.* 1, 110–12 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The self-noise of several windscreens has been obtained at velocities from 5 to 15 m/sec and frequencies from 90 to 3000 c/s. The study indicates an optimal screen flow resistance of $0{\cdot}06\,\rho c$. Streamlining a circular cylinder may reduce the noise 3 db at frequencies 300 to 1000 c/s. The spectrum level of the noise varies as the 6th power of the air velocity near 250 c/s and as the 8th power near 1000 c/s. A.

534.612.2

6402. Probe microphones as laboratory standards. W. WEST. *Acustica*, **4**, *No.* 1, 131–3 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. To minimize standing waves in the probe tube, the "large-bore" probe microphone detects sound pressures on the wall of the tube (at a point remote from the open end) and the tube is terminated to eliminate reflections. The tube of the "small-bore" probe microphone terminates at a small enclosure (the coupler) such that the acoustical impedances of tube and coupler are approximately equal. A.

534.62

6403. A method for measuring sound absorption in the field. C. W. KOSTEN. *Acustica*, **4**, *No.* 1, 108–10 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The arrangement is essentially a normal standing wave tube held against the wall to be tested. Leakage of sound through the absorbing layer is prevented by surrounding the wave tube by another wave tube of greater diameter, properly actuated in the same frequency. The criterion for "no leakage" is equality of sound pressure in both tubes near the same. Preliminary results given corroborate the idea that the method is reliable. A.

534.64

6404. The measurement of acoustic impedance of small samples. O. K. MAWARDI. *Acustica*, **4**, *No.* 1, 112–14 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. A review is presented of some of the better-known methods of measurement of acoustic impedance. The results obtained by these methods are critically examined. The effect of several small-scale phenomena on the results is discussed. The outcome of a survey sponsored by the American Standards Association on the evaluation of normal acoustic impedance from small samples is described and a comparison is made with expected absorption coefficients from reverberation room measurements. A.

534.64

6405. A measuring set for acoustical and mechanical impedances. J. Y. MORTON. *Acustica*, **4**, *No.* 1, 117–20 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The method used is to compare the impedances to be measured with known impedances of the same type. The impedances are applied to electro-acoustical or electro-mechanical transducers which adapt a common electrical circuit for the type of measurement required. Facilities are provided for giving readings of the modulus and phase of the unknown impedance. A.

534.64

6406. The design of an acoustic impedance meter. A. K. NIELSEN. *Acustica*, **4**, *No.* 1, 120–2 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The sound field in a cylindrical tube has been computed for various source configurations. The pressure distribution functions corresponding to simple piston sources are shown graphically, and the computations are utilized in the design of an acoustic impedance meter. Some results of impedance measurements are given. A.

534.771/.773

6407. Audiometry and hearing aids. General review. P. CHAVASSE. *Acustica*, **4**, *No.* 1, 137–40 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953.

534.771/.773

6408. Special problems of speech hearing tests and hearing aid adjustment. F. J. MEISTER. *Acustica*, **4**, *No.* 1, 165–8 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Word-lists for hearing tests can be constructed in two principal ways: firstly, the formalism of equal statistic distribution of phonetic sounds in the words of the test and in normal speech, and secondly the principle of finding equal word-series by frequency-analysis and sorting the words. These principles are discussed and some new results are given for the German language. A.

534.771

6409. Comparative values of hearing deficiencies with a complex noise and with pure tones. P. CHAVASSE AND P. FALCONNET. *Acustica*, **4**, *No.* 1, 145–7 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The problem considered is that of the substitution in audiometry of a single test with a complex noise for the multiple tests commonly made with pure tones in a given frequency band, and of finding whether a correlation exists between results obtained with the two methods. In the absence of a valid definition of the intensity of the white noise, the subjective measurements made were all relative. These related to the thresholds for normal subjects. A.

534.7

6410. The normal threshold of hearing and oth aspects of standardisation in audiometry. R. DADSON. *Acustica*, **4**, *No.* 1, 151–4 (1954).

Paper given at the Congress of the Internation Commission of Acoustics, Netherlands, 19 Describes recent work at the National Physic Laboratory on audiometric standards, with particul reference to the determination of the normal thresh of hearing and developments in the calibration bone-conduction receivers. The N.P.L. thresh measurements agree closely with the results of later investigation by the Central Medical Establis ment of the R.A.F. and are in fair agreement wi those of Sivian and White. The mechanical imp dance of the human mastoid process has be measured, and the results applied to the design of "artificial mastoid" for the objective calibration bone-conduction receivers.

534.81 : 534.2

6411. Electro-acoustics applied to musical instr ments. General review. E. G. RICHARDSON. *Acustic* **4**, *No.* 1, 212–17 (1954).

Paper given at the Congress of the Internation Commission of Acoustics, Netherlands, 1953.

534.81 : 534.2

6412. New results in the electrical production sound and their relation to the mechanical productio of sound. R. BIERL. *Acustica*, **4**, *No.* 1, 218–20 (1954) *In German.*

Paper given at the Congress of the Internationa Commission of Acoustics, Nethe lands, 1953. Mean of expression better than that of electro-mechanica generators are offered by electronic sound generato (without moving parts) allowing the player to chang his pitch, loudness and timbre and so to widen hi musical means of expression. The arrangement o timbres along a closed circle of intervals representin the frequency response curves of the system of vibra tions (for instance, coupled circuits) as well as som features of the spectrum of oscillations exciting th system (viz. the degree of distortion and asymmetry of the oscillations) is not only important for these new types of instruments but can also assist musical acoustical research on the old-established types. A

534.81 : 534.232

6413. Electroacoustic media in progressive musical instrument design. F. TRAUTWEIN. *Acustica*, **4**, *No.* 1, 256–9 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Indica- tions are given, based on hearing characteristics, of the way new developments in musical instruments should go. The commonly employed scale is shown as a principal weakness for melody and harmony on old instrument types. More freedom for the player in melody and strong harmony by frequency division is required. More sharply differentiated timbres can be built up from certain vibrations which by a process of synchronization can be blended in correct phase relationship with each period of the fundamental. A.

534.81 : 534.232

414. What possibilities exist of the serious use of ectronic musical instruments? W. MEYER-EPPLER. *custica*, **4**, *No.* 1, 239–41 (1954) *In German.*

Paper given at the Congress of the International ommission of Acoustics, Netherlands, 1953. Elec- onic instruments give by the choice of tone com- onents a new medium to the composer. It is the usiness of the acoustic expert to educate composers these possibilities. The Cologne Broadcasting tation has built a special "electronic studio" for the se of composers. A.

534.81 : 534.321.3

415. Experimental study of tuning problems. V. KOK. *Acustica*, **4**, *No.* 1, 229–30 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The qual temperament in music is a compromise, accepted n a period not possessing electronic equipment. Organ music especially will recover rich harmony when played with perfect intervals. Methods are described by which this can be done. A.

534.81 : 534.321.3

6416. An acoustical study of the Highland bagpipe. I. M. A. LENIHAN AND S. MCNEILL. *Acustica*, **4**, No. 1, 231–2 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The frequencies and intervals of the notes in the bagpipe scale have been measured by the use of a double beam oscillograph, in conjunction with a valve-maintained tuning fork. A.

534.81 : 534.321.4

6417. Observations on musical consonance. E. SKUDRZYK. *Acustica*, **4**, *No.* 1, 249–53 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Owing to the limited time constant and the non-linear distortion of the human ear the sound impression does not only depend upon the amplitudes, but also upon the phases of the harmonics, i.e. on the envelope of the sound phenomena. This hearing of the envelope is not only important for the sensation of distance and direction, but also plays a fundamental rôle in musical acoustics. It is the cause of numerous acoustic illusions. The hearing of the envelope and the frequency dependence of the internal friction of timber used for musical instruments offer a natural explanation for the quality of old violins. A.

534.81 : 534.321.4

6418. Inharmonicity of piano strings. R. W. YOUNG. *Acustica*, **4**, *No.* 1, 259–62 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The natural frequencies of an actual piano string depart somewhat from the harmonic series; the departure is here called inharmonicity. The inharmonicity has been measured for both bass and treble strings in three sizes of Steinway pianos. The bass strings of the usually preferred grand piano have less inharmonicity than have the corresponding strings of a small upright piano. Tuning is correlated with inharmonicity. A.

534.81 : 534.321.71

6419. The tuning of musical instruments. H. MEINEL. *Acustica*, **4**, *No.* 1, 233–6 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. An account is given of measurements of the normal musical pitch, the construction of an electro-optical tuning apparatus for musical instruments and the results obtained with it. The auditory accuracy of the best tuners is astonishingly high. A.

534.81 : 534.322.1

6420. The effect of voicing adjustments on the tone quality of organ flue pipes. D. M. A. MERCER. *Acustica*, **4**, *No.* 1, 237–9 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Details are given of the tonal effects of the chief adjustments which may be made to a pipe. The effect of pipe diameter in limiting the number of harmonics is explained. Edge tones are shown to be confined to the initial sounds emitted by a pipe, and a new theory of operation of the flue pipe is put forward. A.

534.81 : 534.44

6421. The sounds of bells and organs. M. GRÜTZMACHER. *Acustica*, **4**, *No.* 1, 226–9 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The electroacoustical methods used for getting objective data of the character of a bell or an organ are described. A.

534.81 : 534.44

6422. Recent results obtained in the electroacoustical study of the belly of bowed-string instruments. G. PASQUALINI. *Acustica*, **4**, *No.* 1, 244–9 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The amplitude of vibration of the belly of such instruments, set in forced vibration by an s.h.m. of constant amplitude and varied frequency has been measured. An examination of the response characteristics leads to important conclusions about the musical quality of the instruments derived as purely objective judgments. Results are given from a large number of tests on modern and antique (restored) violins. A.

534.81 : 534.846.4

6423. Stereophonic reproduction of weakly sounding instruments in the concert hall. E. THIENHAUS. *Acustica*, **4**, *No.* 1, 253–6 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The sound of certain instruments can sound weaker in the concert hall than desired. This may be due to the weak sound being a property of the instrument or the instrument being in an unfavourable position. In both cases the sound can be mixed with a stereophonic reproduction of the original. Three examples are given of the use of an electro-acoustic device that does

not change the natural timbre, while the listener is unaware of the use of the reproducing apparatus. A.

534.833

6424. Symposium on the sound insulation of lightweight structures. General review. C. W. KOSTEN. *Acustica*, **4**, *No.* 1, 263–70 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953.

534.833

6425. Some measurements on lightweight double walls. O. BRANDT. *Acustica*, **4**, *No.* 1, 270–3 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Some results of measurements on lightweight double walls are given to show the influence of wall mass, airspace and friction. When introducing heavy sound bridges between two lightweight panels, the low-frequency insulation may be improved. A.

534.833

6426. Calculation of the action of sound bridges. L. CREMER. *Acustica*, **4**, *No.* 1, 273–5 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Energy transfer from beam to slab for longitudinal and flexural waves; transfer from slab to slab, through a short rod forming a bridge; the reduction in impact sound insulation of a floating floor made of cement and one of asphalt with high internal damping by sound bridges; reduction in airborne sound insulation of a lightweight double wall with sound bridges. A.

534.833

6427. The influence of flexural stiffness on the sound insulation of double walls. K. GÖSELE. *Acustica*, **4**, *No.* 1, 276–8 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Double walls of thin leaves frequently give better sound insulation than those with thick stiff leaves, although the latter are much heavier. The most advantageous property of walls with thin leaves is to be ascribed to the small radiation of structure-borne sound below the critical frequency of the leaf. Two practical examples are given of designed sound-insulating lightweight partitions. A.

534.833

6428. Theoretical and experimental study of thin walls and application to the acoustic treatment of aeroplane fuselages. M. KOBRYNSKI, A. NEYRON AND J. BRILLOUIN. *Acustica*, **4**, *No.* 1, 279–81 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Light structures for aircraft construction are studied. They consist of porous materials associated with plastic sheets joined to the metallic skin. The insulation at high frequencies is shown to be very superior to that given by the mass law. The experimental equipment is described. It gives directly the curve of acoustic transmission. An approximate method is given for the calculation of the additional decrease of sound level in an aircraft cabin. A.

534.8

6429. Some fundamental measurements on single a double plate structures. V. M. A. PEUTZ. *Acusti* **4**, *No.* 1, 281–4 (1954).

Paper given at the Congress of the Internatio Commission of Acoustics, Netherlands, 19 Measurements on the transmission loss of plates wood, lead, rubber and aluminium in a reverbera sound field are discussed. In agreement with t results of London *et al.* a rather high insulation found for the low frequencies. The transmission lo of a double wall is compared with that of the cor sponding single wall.

534.8

6430. Sound insulation of some light structur J. PUJOLLE AND R. LAMORAL. *Acustica*, **4**, *No.* 284–8 (1954) *In French.*

Paper given at the Congress of the Internatio Commission of Acoustics, Netherlands, 1953. D ferent types of lightweight structures have be studied; the maximum mass was 15 kg/m², while t area of samples was about 2 m². For a simple w the authors obtained results differing somewhat fr the mass law. For complex structures, considerab improvements were noticed; basic materials we mainly dural, compressed wood and rockwool. The structures were fixed elastically and each eleme independently.

534.8

6431. The influence of the lateral boundary on t sound transmission of simple walls. A. SCHOC *Acustica*, **4**, *No.* 1, 288–90 (1954) *In German.*

Paper given at the Congress of the Internatio Commission of Acoustics, Netherlands, 1953. T transmission of sound through a plate with fini dimensions has been treated theoretically. The resu does not explain the abnormally high values of sou insulation measured on lightweight partitions at lo frequencies.

534.8

6432. Transmission of reverberant sound throug walls. R. V. WATERHOUSE. *Acustica*, **4**, *No.* 1, 290- (1954).

Paper given at the Congress of the Internatio Commission of Acoustics, Netherlands, 195 Further computations of London's expression f the transmission loss *TL* of double walls reveale significant differences between the computed resul and experimental data, both at discrete frequenci and as regards the functional dependence of the los on frequency. To establish more precisely th frequency dependence, particularly in the region o the "coincidence effect," more refined measuremen were made giving *TL* as a continuous function o frequency. Some results are presented.

534.83

6433. Optical methods of measurement in movi air streams. E. J. RICHARDS. *Acustica*, **4**, *No.* 126–8 (1954).

Paper given at the Congress of the Internationa Commission of Acoustics, Netherlands, 195 Describes a technique used in research on noise fro

is. A new schlieren system has been developed hich allows the measurement of the velocities and equencies of eddies moving downstream which are tuated on the edges of both two and three dimenonal jets. A focusing schlieren method is put rward in conjunction with this technique in which e turbulence of eddying flow at a discrete point side the jet may be measured. Applications of the chnique to shock wave oscillations, speed measureent, etc., are suggested. A.

534.843

434. Automatic recording of frequency irregularity rooms. P. V. BRÜEL. *Acustica*, **4**, *No.* 1, 21–5 954).

Paper given at the Congress of the International ommission of Acoustics, Netherlands, 1953. To ave the tedious job of calculating the frequency regularity FI from a room response curve, two ifferent methods for obtaining direct recording of the I as a function of frequency are developed. In the ne method the room response is recorded with a icrophone, amplifier and level recorder. On the ecorder is fixed a contact strip with 100 silver amellae which by means of an electronic scaler egisters the total "length" of the room response urve in db. The other method uses the output oltage from the moving coil in the level recorder. his voltage is proportional to the FI and is recorded n a second level recorder with extremely low recordng speed. The two sets of apparatus have been used or measuring the diffusion effect of three different ypes of diffusers in a small model room. A.

534.843

435. The behaviour of sound in a room with absorbng walls. S. EUTIZI. *Alta Frequenza*, **23**, 3–15 *Feb.*, 1954) *In Italian.*

An equation is derived for the eigenvalues of the roblem of sound propagation inside a parallelepiped with absorbing walls. The equation, obtained in the orm of a series, is solved in 3rd approximation for he case of a cube. Examples are given, and an xpression is derived for the absorption coefficient, which generalizes previous formulae. L. PINCHERLE

534.845.1

436. Measurements of coefficients of reflection in mplitude and phase. A. C. RAES. *Acustica*, **4**, *No.* 1, 123–5 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. A description is given of three methods which proved to be useful in architectural acoustics. The main principle is to separate the incident and the reflected waves in time and space so that they can be measured independently of each other. Calculations are thus reduced to a minimum. (1) Acoustical transmission line tests. Convenient to test small samples under normal incidence. Allows great operational speed. A direct reading reflection coefficient meter is described. (2) Free room tests. Designed to test absorbing materials, including vibrating panels and curtains, *in situ* and without touching them, under normal incidence. (3) Oblique incidence tests. Development of the preceding case. A.

534.846.1

6437. Sound-reflecting surfaces. F. W. J. SCHWEIGMAN. *Acustica*, **4**, *No.* 1, 89–91 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The human voice of average power can be well heard and understood by an audience larger than usually taken for granted, if the sound energy is well utilized by reflection of walls, ceiling and partitions. It is possible to design the reflecting surfaces in such a manner that for all listeners the sound level and intelligibility have the same value, independent of the varying distances from the speakers. A.

534.846.4

6438. Public address systems. Introduction. E. MEYER. *Acustica*, **4**, *No.* 1, 53–61 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953.

534.846.4

6439. Experiences with electroacoustic equipment used at the Olympic Games in Helsinki 1952. P. ARNI. *Acustica*, **4**, *No.* 1, 61–3 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. A public address system with loudspeaker arrays as well as a system with loudspeakers spread over a distance, keeping the mutual distance between adjacent units within 17 m, were used. A composite mixture of evenly spoken speech was used for testing the uniformity of sound distribution. Research on echo-effects was carried out using short pulses recorded in the field on level recorders. Both systems mentioned above give uniform distribution and good reproduction, at least out of doors. A.

534.846.4

6440. Artificial acoustical environment control. H. S. KNOWLES. *Acustica*, **4**, *No.* 1, 80–1 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The acoustic field at the listener differs markedly in a concert hall and in an outdoor amphitheatre. To provide a sound field outdoors approximating to that of a hall an array of loudspeakers was suspended over and around an outdoor area and supplied with multiply delayed, attenuated and spectrally modified signals. Listeners showed a significant preference for the simulated indoor acoustical environment even when presented with a visible outdoor environment. A.

534.846.4

6441. The application of the Haas effect to speech reinforcement systems. P. H. PARKIN. *Acustica*, **4**, *No.* 1, 87–9 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Points out that, although it had long been obvious that speech reinforcement systems using several distributed loudspeakers could be improved by arranging for the sound from the various loudspeakers to arrive more or less simultaneously at the listeners, it was not until the work of Haas that it was known how to adjust the

successively arriving sounds in amplitude and in time sequence so that maximum realism and intelligibility were achieved. Three recent systems in Great Britain which apply the Haas effect are described, the most important one being that in St. Paul's Cathedral, London. This last system also employs directional loudspeaker arrays (columns). A.

534.86

6442. The establishment of quality standards by subjective assessment. T. SOMERVILLE. *Acustica*, **4**, *No.* 1, 48–50 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. B.B.C. methods are described. The B.B.C. endeavours to reproduce the original sound because only in this way is a reliable standard available. From considerable experience it has been found to be quite impossible to make reliable comparisons subjectively unless the acoustics of the originating studio are good. Loudspeaker testing is used as an example, although the methods are applicable to other types of electro-acoustic equipment. A.

534.862.3

6443. Sound recording. General review. R. VERMEULEN. *Acustica*, **4**, *No.* 1, 17–21 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953.

534.862.3

6444. Some problems in disk recording of sound. F. SCHLEGEL. *Acustica*, **4**, *No.* 1, 45–7 (1954) *In German.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Certain problems are discussed with special reference to cutting heads damped by countercoupling only. Data are given on a cutting head not described in one of the principal languages. A.

534.862.4

6445. Stylus-groove relations in the phonograph playback process. F. V. HUNT. *Acustica*, **4**, *No.* 1, 33–5 (1954).

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. The motion of a gramophone pickup stylus in a lateral-cut record groove is analysed with due regard for the first-order effects of elastic deformation of the groove walls. The relative response at any frequency is governed in part by a groove pick-up response function embodying the effect of resonance between the compliance of the groove and the effective mass of the stylus. A translation-loss function further controls the response at fundamental frequency only and imposes a sharp cut-off at a recorded wavelength which is a function of the stylus and record parameters. The distortion response at harmonic frequencies is effectively controlled by a scanning-loss function, which also varies with the recorded wavelength and which imposes its own cut-off at a somewhat shorter wavelength. Experimental measurements with special test recordings confirm the theoretical predictions. A.

534.86

6446. A system for stereophonic reproducti V. L. JORDAN. *Acustica*, **4**, *No.* 1, 36–8 (1954).

Paper given at the Congress of the Internatio Commission of Acoustics, Netherlands, 1953. Wh listening to two loudspeakers transmitting the sa sound signal, the relation between the angular d placement of the virtual sound source and the diff ence in intensity, level of the two sources is lin within a certain range, and a mean value of the sl of the curve may be fixed at 0·5 db per degree angle. This implies the use of microphones w suitable directional characteristics. The stereopho impression of a two-channel system arranged acco ing to this principle is rather satisfactory, althou the level is a little too low for sounds originating cl to the axis of symmetry.

OPTICS . RADIATION . SPECTRA 535

535.14 : 535.

6447. The theory of images and radiation. II. attempt at a photon-optics. P. M. DUFFIEU *Cahiers de Phys.*, *No.* 47, 5–35 (*Jan.*, 1954) *In French*

Using the results of Pt I [Abstr. 5369 (1953)], t author considers some basic theorems of photo optics and compares this method with convention geometrical and physical optics. Outstanding pro lems of diffraction, polarization and reflection a discussed and it is suggested that these problems m be overcome if they are treated as interactio between material objects and light, rather th mutual interactions of light and light. The laws diffraction can then be satisfied if it is assumed th the photon is deformed by collision with mate objects. R. W. FI

535.2

6448. Note concerning radiation pressure again perfect reflectors. J. E. RHODES, JR. Letter in *Am J. Phys.*, **22**, 96–7 (*Feb.*, 1954).

535.214

6449. A new radiometer. J. T. HOUGHTON AN A. W. BREWER. *J. sci. Instrum.*, **31**, 184–7 (*Ma* 1954).

A radiometer, which measures directly the flux radiant energy integrated throughout a hemisphe is described. It consists of a very light electric resistance thermometer element which is suspende thermally isolated in high vacuum, behind an infrar transmitting window. The front is blackened receive the radiation, while the back is a bright mirr to prevent absorption or emission. The eleme comes into thermal equilibrium at a temperature T with an incoming radiation stream of energy F. The $F = \sigma T^4$, with small corrections for heat leakag The determination of these corrections is the on calibration which is necessary. The radiometer robust, reasonably rapid in response, and is n affected by external airflow. For these reasons it especially suitable for radiative flux measurements the upper air from an aircraft. It may have oth

es in heating and ventilating problems or wherever w temperature radiation is important. A.

535.23 : 536.521

50. The emissivity of a groove. L. F. DAWS. *it. J. appl. Phys.*, **5**, 182–7 (*May*, 1954).

In order to check the performance of any tempera- re measuring device, which is dependent on radia- on, a standard radiator should be available which ossesses a thermal emissivity as close to unity as ossible. One way the emissivity may be increased to use a grooved target and in this paper an estimate made of the improvement to be expected by using ch a target. The variation of the effective emis- vity with sighting angle is determined. It is shown at a grooved target behaves as a Lambert surface hen the angle of sighting is within a groove apex ngle, but that this is no longer true for other sighting ngles. The mean effective emissivity over all sight- g angles is calculated using the relaxation method or a graphite target having a surface emissivity of ·64 before grooving. After grooving it becomes ·77, 0·82 and 0·82 for groove apex angles of 60°, 0° and 15° respectively. The corresponding emis- ivities when the angle of sighting is within the groove pex angle are 0·78, 0·88 and 0·94 respectively. A.

535.241.39

5451. Construction and study of a luminescent lamp as a secondary standard for spectral distribution. P. GUÉRIN. *Rev. Opt.*, **33**, 137–45 (*April*, 1954) *In French.*

The lamp, made for stellar spectrophotometry, gives a continuous spectrum from 2900 Å to beyond 5500 Å. It consists of a layer of microcrystalline luminescent salts, excited by 2537 Å radiation from a mercury lamp, isolated by an absorbing liquid. The spectral distribution of this source is stable and well defined and is practically independent of the exciter lamp. A.

535.3

6452. Scintillation limitations to resolving power in imaging devices. J. W. COLTMAN. *J. Opt. Soc. Amer.*, **44**, 234–7 (*March*, 1954).

The theoretical performance limit of an imaging device may in many cases depend upon the quantum fluctuation noise of the signal itself. Experiments on the ability of the eye to recognize a regular pattern delineated by randomly fluctuating scintillations are described, and the data are used to calculate the resolving power of an ideal image intensifier used with an X-ray fluoroscope. It is shown that the ultimate resolving power in such a system may ideally exceed even that of ordinary screen-film radiography. A.

535.31

6453. Axiomatic geometrical optics. R. BOOLSKY. *Helv. phys. Acta*, **26**, *No.* 7–8, 743–54 (1953) *In French.*

Claims to represent the image-forming properties of systems by means of so-called "iconal models," which is defined to be the geometrical construction by means of which the image-formation by a perfect system is defined. Some applications are briefly discussed. H. H. HOPKINS

535.31

6454. Analytical verification of optical systems. C. MORAIS. *Atti. Fond. Ronchi*, **8**, 346–52 (*Sept.–Oct.*, 1953) *In Italian.*

Formulae are given which enable a merely algebraical calculation to be made of the tracing of skew and meridian rays through an optical system. A complex variable is introduced because the present work has been deduced from a general one where optical aberrations are treated by means of such a variable. A.

535.31 : 538.56

6455. Stepwise transition from wave optics to ray optics in inhomogeneous anisotropic absorbing media. II. Solution of the wave-normal equation and refractive-index equation using the WKB approximation. Ray-optical reflection and alternation. K. SUCHY. *Ann. Phys.* [*Leipzig*], **13**, *No.* 1–5, 178–97 (1953) *In German.*

Subject to stipulated conditions the wave equations for E and H may be transformed to give equations describing both the polarization and the eikonal functions for any medium. [See Pt I, Abstr. 2310 (1953).] These equations are now solved using the WKB approximation. Conditions are derived for the existence of reflection and alternation points. This latter term is used to denote a transition from one to the other of the two possible modes of propagation in an anisotropic medium. H. H. HOPKINS

535.313

6456. Improvement of resolving power of optical systems by a new optical element. A. BOUWERS. Letter in *Appl. sci. Res. B*, *No.* 2, 147–8 (1953).

A glass cone of very small slope, the apex angle being nearly 180°, is used to correct residual under-corrected spherical aberration of a large aperture ($f/0·9$) mirror system. Examples of the improvement obtained are quoted. R. W. FISH

535.317

6457. Least-squares method for optical correction. S. ROSEN AND C. ELDERT. *J. Opt. Soc. Amer.*, **44**, 250–2 (*March*, 1954).

This paper represents an attempt to make use of modern computing machinery in a direct attack on the problem of correcting a partially corrected optical system. By ray-tracing difference coefficients are computed for a set of rays with respect to bendings of the individual lenses of a system. Assuming linear behaviour over a small region a set of linear equations is derived for the desired corrections. The method of least squares gives a "best possible" solution of the equations. A.

535.317.6

6458. Graphical method for the choice of glasses for cemented objectives with arbitrary values of ΣA, ΣB, $\Sigma\varphi/\nu$. M. CORRIAS. *Atti Fond. Ronchi*, **8**, 406–22 (*Nov.–Dec.*, 1953) *In Italian.*

535.317.9

6459. Lens system producing unequal magnification in two mutually perpendicular directions. D. R. BUCHELE AND H. R. GOOSSENS. *Rev. sci. Instrum.*, **25**, 262–3 (*March*, 1954).

A camera lens system, applicable to a schlieren optical system, is described, that yields an image in which the magnification perpendicular to the airflow

is much greater than the magnification parallel to the airflow. Examination of boundary layer development along an airfoil surface is thereby facilitated. Optical design formulae are given and illustrated by an example in which a 24 to 1 ratio of magnifications is obtained without loss of schlieren sensitivity and without noticeable aberrations. A.

535.323/.325 : 530.145

6460. A quantum-mechanical definition of refractive index. S. M. NEAMTAN. *Phys. Rev.*, **94**, 327 (*April* 15, 1954).

The refractive index is defined in terms of momentum and energy changes in first-order transitions of a system consisting of the particles of a refractive medium in interaction with the electromagnetic field. A.

535.33.03

6461. The construction of a combined sources unit for emission spectrography. R. G. STONE AND H. L. BOLTON. *J. sci. Instrum.*, **31**, 175–8 (*May*, 1954).

The unit contains the circuits of the following spectrographic sources; two intermittent a.c. arcs, one pulsed d.c. arc, one constant current d.c. arc and a condensed spark. A conventional d.c. arc operated from d.c. mains supply is also included. Oscilloscope presentation of potential and current pulses across the analytical gap is supplied by three cathode-ray tubes. A.

535.33.07

6462. On a comparison between graphite arcs and a u.v. standard [of radiation intensity]. J. EULER. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 145–73 (1954) *In German.*

Describes, in considerable detail, measurements made on the u.v. radiation (2652 to 3132 Å, with further data in the visible at about 4340 and at 5461 Å) from carbon arcs. Measurements were made relative to u.v. standard sources, and careful comparisons with the work of previous authors are drawn. Details of the optical systems, etc., are given. Arc temperatures, at about 4000°K, are given to ±15°K. J. D. CRAGGS

535.33.07

6463. The advantages of controlled atmospheres for arc spectroscopy. R. A. THIERS. *Appl. Spectrosc.*, **7**, 157–63 (*Nov.*, 1953).

Gives a general description of the comparative behaviour and properties of d.c. spectroscopic-source arcs in air, CO_2, N_2, O_2, steam, A and He. Attention is directed towards such matters as reduction of background, detection sensitivities, variation of burn-off time, etc. Typical spectra are shown. J. D. CRAGGS

535.33.07–14

6464. 1·5 cm wavelength microwave spectroscope. I. TAKAHASHI, A. OKAYA, T. OGAWA AND T. HASHI. *Mem. Coll. Sci. Univ. Kyoto A*, **26**, 113–21 (*Oct.*, 1950).

Details of an apparatus employing crystal doubling from 3 cm and of its performance for the J_{0-1} line of CH_3Br. D. H. WHIFFEN

535.338.33

6465. "Magnetic-scanning" method for investigating hyperfine structure and isotope shift. S. MROZOWSKI. Letter in *Phys. Rev.*, **93**, 641–2 (*Feb.* 1, 1954).

Bitter *et al.* [Abstr. 7558 (1953)] found that although magnetic scanning gave the relative positions of h.f.s., components of the 2537 Å Hg line in agreem with their known positions, the measured intensi disagreed. The interpretation of this by Bitter *et* is shown to be untenable, and it is suggested that differences are due to the method of observation. J. HUGE

535.33

6466. Rotational analysis of some bands of the b system of the SrO molecule. I. DEÉZSI, E. KOCZK AND T. MÁTRAI. *Acta phys. Hungar.*, **3**, *No.* 2, 95–1 (1953) *In German.*

The 1, 0, 1, 6 and 2, 6 bands have been analyse The constants derived are: $B'_v = 0{\cdot}2937_7 - 0{\cdot}00$ $(v' + \frac{1}{2})$; $B''_v = 0{\cdot}3380_9 - 0{\cdot}0021_3(v'' + \frac{1}{2})$; ω'_e $519{\cdot}9_1$, $x'_e\omega'_e = 3{\cdot}2_4$; $\omega''_e = 653{\cdot}3_7$, $x''_e\omega''_e = 3{\cdot}$ [See also Abstr. 7561 (1953).] R. F. BARRO

535.338

6467. Intensity formulae for bands involving hi multiplicity terms. III. $^6\Pi - {}^6\Sigma$ and $^6\Pi -$ transitions. D. PREMASWARUP. *Indian J. Phys.*, **2** 48–52 (*Jan.*, 1954).

For Pt II, see Abstr. 5439 (1954).

535.338

6468. The emission band spectrum of Cl_2^+. TIRUVENGANNA RAO. *Proc. Nat. Inst. Sci. India*, **2** 70–3 (*Jan.–Feb.*, 1954).

The emission spectrum of chlorine has been excit in a high frequency discharge tube containing a sma quantity of $NbCl_5$ using a three-prism glass Littro spectrograph. An examination of the spectru revealed the existence of about 30 new ban attributable to Cl_2^+ in addition to those reported b Elliott and Cameron (1938). A vibrational analys of these bands has shown that they belong to su system I of Cl_2^+ bands analysed by them on the bas of a $^2\Pi$–$^2\Pi$ transition. About 15 bands have bee newly classified, the remaining being the isotop heads due to the less abundant molecule $Cl^{35}Cl^{37}$ The vibrational assignment of each one of the ban is well supported by the observed isotope effect.

535.338

6469. Spectra of the molecules CN and CN^+. A. E. DOUGLAS AND P. M. ROUTLY. *J. Phy Radium*, **15**, 203–4 (*March*, 1954) *In French.*

The discharge emission spectrum of helium con taining cyanogen was taken. Various bands no observed previously were found: it is shown that thes bands belong to two systems of CN^+ ($d'\Sigma$–$a'\Sigma$ an $f'\Sigma$–$a'\Sigma$) and to four systems of CN($H^2\Pi$–$B^2\Sigma$ $F^2\Delta_r$–$A^2\Pi_i$, $D^2\Pi_j$–$A^2\Pi_i$ and $D^2\Pi$–$X^2\Sigma$). A. J. TAYLO

535.338

6470. The spectrum of the CN^+ molecule. A. E DOUGLAS AND P. M. ROUTLY. *Astrophys. J.*, **119** 303–11 (*March*, 1954).

In a discharge through He mixed with a trace o C_2N_2, two new band systems have been found. I has been shown that these systems are due to tw $^1\Sigma - {}^1\Sigma$ transitions of the CN^+ molecule. For th first system the following constants have been deter mined: $\nu_{00} = 45\,844{\cdot}6$, $B'_0 = 1{\cdot}8870$, $B''_0 = 1{\cdot}8868$ $\omega'_e = 2670{\cdot}5$, $\omega''_e = 2033{\cdot}0\ cm^{-1}$. The second sys tem, which has the same lower state as the first

nnot be completely analysed because of perturbations and overlapping. Probable values of the nstants are $\nu_{00} = 31\,381{\cdot}6$, $\omega'_e = 1265$, and $B'_0 = 402\ cm^{-1}$. Four bands, as yet unidentified, are scussed. A.

535.338.4

471. Rotational analysis of the β band system of e NS molecule. R. F. BARROW, G. DRUMMOND AND B. ZEEMAN. *Proc. Phys. Soc.* [*London*] *A*, **67**, 5–77 (*April*, 1954).

Rotational analyses of the 1, 0, 0, 0 and 0, 1 nds of the β-system of NS have been carried out. is found that the transition is $^2\Delta$–$^2\Pi$ and not $^2\Sigma$–$^2\Pi$ as has hitherto been supposed. The rotational nstants of the state $A^2\Delta$ are: $B_v = 0{\cdot}6960_4 - 0{\cdot}0069_5(v + \frac{1}{2})$; $r_e = 1{\cdot}576_8$ Å. In the same spectral gion there occur the $c^2\Sigma$–$x^2\Pi$ system (γ-bands) and ther weaker bands which may belong to a system $(^2\Pi)$–$x^2\Pi$. A.

535.338.4 : 523.67

472. The λ4050 group of cometary spectra in the cetylene-oxygen flame. N. H. KIESS AND A. M. BASS. etter in *J. chem. Phys.*, **22**, 569–70 (*March*, 1954).

The 4050 Å cometary emission band, observed also n laboratory flame reactions of F with certain organic ompounds, has recently been found in the spectrum f a fuel-rich C_2H_2, O_2 flame. The band-system esembles closely that described by Douglas (1951) in discharge between C electrodes although, because f the much higher flame temperature, the new pectrum is richer in lines. D. R. BARBER

535.338.4 : 539.132

473. The λ4050 bands of the C_3^{13} molecule. K. CLUSIUS AND A. E. DOUGLAS. *Canad. J. Phys.*, **32**, 319–26 (*May*, 1954).

The λ4050 bands, excited with the pure C^{13} isotope, ave been photographed under high resolution. The ines of the strongest band show a 3 : 1 intensity lternation. The B values of the C^{13} band are in the atio 12 : 13 to the B values of the corresponding C^{12} and. These isotope effects are interpreted as giving ery good evidence that the λ4050 band is emitted by triatomic carbon molecule C_3. A.

535.338.42–15

474. Flame-emission spectrum of water vapor in he 1·9-micron region. W. S. BENEDICT, A. M. BASS AND E. K. PLYLER. *J. Res. Nat. Bur. Stand.*, **52**, 61–76 (*March*, 1954).

The emission of hydrogen-oxygen and acetylene-oxygen flames has been studied by using a 15 000 lines per in. grating spectrometer with a lead sulphide photoconductive detector. The water-vapour band, which in room-temperature absorption extends from about 1·80 to 1·96 μ, is broadened in emission to 1·7 to 2·2 μ. Nearly 1000 lines have been measured, and a rotational analysis has been given for many of them. Many lines of the (011–000) band agree with those found in laboratory and atmospheric absorption, and many additional lines from higher energy levels may be identified. The principal series $J_{-J} \longleftrightarrow (J+1)_{-(J+1)}$ may be followed out to $J = 23$ in both P and R branches. Corresponding lines in the upper-state bands (021–010) and (031–020) have also been identified. A smaller number of lines may be assigned to the (041–030), (051–040), (012–001), (022–011), (032–021), (111–100) and (121–110) bands. A.

535.343–14

6475. A method for the estimation of the relative intensities of microwave absorption lines. D. H. BAIRD AND G. R. BIRD. *Rev. sci. Instrum.*, **25**, 319–23 (*April*, 1954).

An examination of the theoretical relationship between absorption and crystal response in a Stark-effect microwave spectrograph indicates that a direct proportionality exists between the absorption coefficient and the component of crystal current at the modulation frequency, provided that certain reasonable conditions are fulfilled. An experimental method is described which utilizes this principle to obtain measurements of the ratio of one absorption coefficient to another. This method involves a matching of the modulation frequency component of crystal current against an adjustable reference signal. These measurements may be used to determine the energy separation of the lower states of the lines observed, thus yielding microwave data on vibrational or torsional energy levels. Line breadth and saturation can be measured equally well with minor modifications in method. This experimental method was tested by measuring the known ratios of absorption coefficients of the carbonyl sulphide lines near 24 000 Mc/s which are assigned to various isotopic species. The range of deviation of measured ratio from known ratio was 25%, and this discrepancy is attributed to reflections in the microwave transmission line, particularly at the ends of the Stark electrode. The determination of molecular vibrational or torsional energy levels is discussed. A.

535.343–14

6476. Note on the estimation of absolute absorption intensities with a Stark-modulated microwave spectrograph. G. R. BIRD. *Rev. sci. Instrum.*, **25**, 324–6 (*April*, 1954).

The method developed (see preceding abstract) for the measurement of relative absorption intensities has been extended to the estimation of absolute absorption intensities. The estimation of absolute intensity is based on the measurement of the ratio of modulation-frequency component to direct component of crystal current at low microwave power levels. A preliminary test of the method has been conducted by making measurements on the intensity of the line CH_3Cl^{35}, $J = 0 \rightarrow 1$, $F = \frac{3}{2} \rightarrow \frac{5}{2}$ over a range of crystal currents. Measured intensities less than the calculated intensity by 15% to 25% were observed over a range of nine in crystal current, indicating that the method is at least feasible for the estimation of intensities. Even crude estimates can be extremely useful in the identification of spectral lines, and it seems likely that the method admits of much refinement in accuracy. A.

535.343–14 : 539.132

6477. Microwave resonance in nitric oxide: lambda doubling and hyperfine structure. R. BERINGER, E. B. RAWSON AND A. F. HENRY. *Phys. Rev.*, **94**, 343–9 (*April* 15, 1954).

The microwave spectrum arising from transitions between Zeeman levels in the $^2\Pi_{\frac{1}{2}}$, $J = \frac{3}{2}$ state of nitric

oxide is reinvestigated with particular regard to the λ-doubling which is observable for electric-dipole transitions. This doubling is compared with the theory of Karnaugh. The experiments also give a new and improved determination of the nuclear hyperfine coupling constants and of the molecular splittings. The theory of the hyperfine effect is re-examined in detail. A.

535.343–15

6478. Infrared spectra of carbonyl derivatives of type R′–CO(CH_2–CH_2)$_n$CO–R″ containing more than ten methylene groups. H. PRIMAS AND H. H. GÜNTHARD. *J. Phys. Radium*, **15**, 209–11 (*March*, 1954) *In French.*

An interpretation is given of the infrared spectra for values of n in the range 7 to 21, where R′ and R″ represent CH_3 and OCH_3. The type of spectra seems to be independent of the nature of R′ and R″, and the different modes of vibration possible in the central methylenic chain are discussed.

G. I. W. LLEWELYN

535.343–15 : 535.375.5 : 539.133

6479. Vibration spectra of diatomic polar groups. E. GRAY. *J. Phys. Radium*, **15**, 200–2 (*March*, 1954) *In French.*

The 1700 cm^{-1} absorption band of aldehydes and ketones is very broad, which suggests that it is composed of various minor bands. This is investigated. Three different frequencies are found in the band. It also appears in exactly the same way in Raman spectra, but with a slight shift towards longer wavelengths. This leads to the conclusion that two CO groups must be arranged so that there exists a centre of symmetry: their orientation is antiparallel. As the P and R branches are not equally intense, it is suggested that they are not caused by a simple rotation but by a pivoting motion. A. J. TAYLOR

535.343–31

6480. The ultraviolet absorption spectra of α-chloro- and α-bromonaphthalene in different states. A. R. DEB. *Indian J. Phys.*, **28**, 21–30 (*Jan.*, 1954).

The near ultraviolet absorption spectra of the vapour, liquid and solid states were photographed, using very thin films of the substances in the case of liquid and solid states. In the vapour state α-chloronaphthalene yields 17 bands between 2896 Å and 2495 Å. The first band on the longer wavelength side at 34 520 cm^{-1}, has been assigned as the ν_0 band. The other bands correspond to vibrational frequencies 273, 508, 1401 and 1505 cm^{-1} and their progressions, the frequency 1401 cm^{-1} being the most prominent. In the liquid state the ν_0 band shifts by 1135 cm^{-1} towards longer wavelengths and only four broad bands are observed. The distance between the centres of these successive bands is 1375 cm^{-1}. In the solid state at −180°C, the ν_0 band further shifts towards longer wavelengths by 337 cm^{-1}, and the vibrational frequency 1375 cm^{-1} of the liquid state is changed to about 1424 cm^{-1}. In the case of α-bromonaphthalene in the vapour state 11 bands have been observed with the ν_0 band at 34 528 cm^{-1} and progressions of two vibrational frequencies 496 and 1380 cm^{-1}. In the liquid state at room temperature the ν_0 band is shifted towards longer wavelengths by 1321 cm^{-1} and only four broad bands, correspon ing to vibrational frequency 1343 cm^{-1} are observe At −180°C in the solid state the ν_0 band further shi towards longer wavelengths by 355 cm^{-1} and vibrational frequency 1343 cm^{-1} of the liquid state changed to about 1400 cm^{-1}. The ν_0 band becom appreciably sharper at −180°C, though other ban do not show any sharpening. Both the substances the liquid and solid states show some very feeble ban in the region between 3250 Å and 3050 Å, when fil of thickness about 0·1 mm are used. The positio of these bands shift slightly towards longer wa lengths with solidification of the substances a lowering of temperature to −180°C.

535.34

6481. Excitons in cuprous oxide crystals at t temperature of liquid helium (4·2°K). E. F. GRO B. P. ZAKHARCHENYA AND N. M. REĬNOV. *Do Akad. Nauk SSSR*, **92**, *No.* 2, 265–7 (1953) *In Russia* English translation, *U.S. National Sci. Found. NS tr*-185.

At 4·2°K the hydrogen-like series of absorption lin previously observed [Abstr. 5389–90 (1953)] beco narrower and are displaced to shorter wavelengt In addition new weak lines also appear and the lim of continuous absorption is at 5841 Å. The new lin are attributed to splitting of the exciton levels, excitons associated with impurities in the Cu_2O or a fine structure effect. G. F. J. GARLIC

535.343.2 : 548

6482. A new absorption band in lithium fluori irradiated by X-rays. A. JOHANNIN-GILLES. Lett in *J. Phys. Radium*, **15**, 192 (*March*, 1954) *In Frenc*

In addition to the 2200 Å band due to *F*-ban bleaching [Abstr. 6646 (1953)] a band extending fro 2000 Å to 1630 Å is found. It is considered to more like the *K* band of Uchida, Ueta and Nak [Abstr. 6134 (1951)] than the β-lattice perturbati band. G. F. J. GARLIC

535.343.2–14/15 : 539.11 : 548

6483. Study of crystal defects in solids with the a of Hertzian absorption: relationship with infrar absorption. M. FREYMANN AND R. FREYMAN *J. Phys. Radium*, **15**, 217–19 (*March*, 1954) *In Frenc*

A brief review including discussion of KCl, ZnO U_3O_8, B, Se, etc. D. H. WHIFFE

535.343.2–14 : 539.

6484. Hertzian spectrum and structure of solid II. Debye absorption of free water and bound wate M. FREYMANN AND R. FREYMANN. *J. Phys. Radium* **15**, 165–75 (*March*, 1954) *In French.*

For Pt I, see Abstr. 5606 (1953). A review of th dielectric loss behaviour of H_2O in ice, frozen sa solutions, alumina, silica gel, KCl, NaCl, ferric alum starch, etc. D. H. WHIFFE

535.343.2–1

6485. Attempt to interpret the infrared absorptio spectra of solid and liquid saturated aliphatic acid C. RIGAUX. *C.R. Acad. Sci.* [*Paris*] **238**, 783– (*Feb.* 15, 1954) *In French.*

Most of the bands are attributed to vibrations o the groups COOH, CH_2 and CH_3. C–C vibration are too weak to identify with certainty. G. F. LOTHIA

535.343.32

486. Spectra and constitution of donor-acceptor complexes of iodine. J. A. A. KETELAAR. *J. Phys. Radium*, **15**, 197–200 (*March*, 1954) *In French.*

Brown or red iodine solutions show an absorption band in the visible region (4600–4800 Å) and a more intense band in the ultraviolet (2700–3700 Å), which is not shown by the gas. Some of the violet solutions also show a band in this region. Spectra were taken of solutions of iodine in mixtures of inert and active solvents. The equilibrium constant of the reaction forming the complex was found by a graphical method. At all concentrations of the two liquids the iodine associated with one molecule of active solvent. It is suggested that the iodine complex is stabilized by resonance of two configurations. The dissociation energy of such complexes is calculated for various solvents. A. J. TAYLOR

535.343.32 : 535.371 : 541.24 : 541.64

487. Spectroscopic and fluorescence determination of the molecular weight of high chain-polymers. E. EINTZ. *J. Phys. Radium*, **15**, 219–21 (*March*, 1954) *In French.*

Visible spectra of some chemicals vary according to the solvent used. This fact is used here for the evaluation of molecular weights of high polymers. If rhodamine B is dissolved in polystyrene or ethylbenzene there appear bands which are absent when it is dissolved in chloroform. In the latter solution it is very fluorescent, but not in the other solvents, which inhibit fluorescence. The intensity of the fluorescence depends on the molecular weight of the solvent. An equation describing this is derived, which fits experimental curves of decrease in fluorescence against concentration of the inhibitor. From this relations are found which involve the molecular weight more directly. A. J. TAYLOR

535.343.32–15

488. Variations with temperature and dilution of the infrared absorption spectra of benzene-like derivatives of phenol. M. NEUILLY. *C.R. Acad. Sci.* [*Paris*] **238**, 781–2 (*Feb.* 15, 1954) *In French.*

Measurements on xylenols and halogen (X) substituted phenols show changes between liquid and solid forms except when a CH_3 or X group is adjacent to the OH group; it is suggested that in the latter cases intermolecular association at the OH group is hindered by the adjacent groups. With nitro-substituted compounds this effect is found only when there are 2 groups adjacent to the OH group.

G. F. LOTHIAN

535.343.4–14

489. New spectra of $H_2C^{12}O$ in 6 mm wave range. K. OKAYA. *J. Phys. Soc. Japan*, **9**, 135–6 (*Jan.–Feb.*, 1954).

535.343.4–15

490. High-dispersion infrared spectrum of $CH_2 = CHD$. C. COURTOY AND M. DE HEMPTINNE. *Ann. Soc. Sci. Bruxelles*, **67**, *Sér.* 1, *No.* 3, 285–95 (1954) *In French.*

Three bands, at 2072, 2124 and 2885 cm^{-1} found previously [Abstr. 8797 (1952)] are discussed. The infrared spectrum was also taken from 4020 cm^{-1} to 4785 cm^{-1} and a large number of bands found. Most bands could be assigned as combinations and harmonics, involving rotational fine structure, so that the shift caused by anharmonicity was of reasonable order. Some anharmonicity constants were determined. A. J. TAYLOR

535.343.4–15

6491. High-dispersion infrared spectrum of the molecule CD_2H–CD_2H. R. VAN RIET, C. COURTOY AND M. DE HEMPTINNE. *Ann. Soc. Sci. Bruxelles*, **67**, *Sér.* 1, *No.* 3, 296–308 (1954) *In French.*

The spectrum was taken and analysed from 900 to 3000 cm^{-1}. The molecule has two chemically inseparable configurations, one of symmetry C_{2h} and one of C_2. For both forms two moments of inertia are approximately equal, so that the molecule can be considered as a symmetric top, and the spectrum should contain parallel, perpendicular and hybrid bands. This gave good agreement with the spectrum obtained. The bands were assigned and rotation constants calculated, which compared well with theoretical values. A. J. TAYLOR

535.343.4–31

6492. The absorption spectrum of gaseous aluminium monofluoride in the Schumann region. R. F. BARROW AND H. C. ROWLINSON. *Proc. Roy. Soc. A*, **224**, 134–40 (*June* 9, 1954).

The absorption spectrum has been examined in the region 1250 to 2000 Å. Six new singlet band-systems have been found. Four of the excited states have also been observed in emission in transitions to the lowest excited singlet state $A^1\Pi$, at longer wavelengths. The energies and products of dissociation of some of the states are considered. A.

535.343.4–32

6493. On the absorption spectrum of water vapour in the Schumann ultraviolet. A. JOHANNIN-GILLES AND B. VODAR. *J. Phys. Radium*, **15**, 223–4 (*March*, 1954) *In French.*

The band covering 1600–1700 Å shows several peaks; Beer's law does not hold when the pressure is varied; it is considered that this band causes decomposition to H + OH. Absorption of quartz in this region is given for 20–900°C. G. F. LOTHIAN

535.343.4–32

6494. The far ultraviolet absorption spectra of the isomeric butenes. J. T. GARY AND L. W. PICKETT. *J. chem. Phys.*, **22**, 599–602 (*April*, 1954).

Measurements of the intensity and position of absorption from 45 000 to 64 000 cm^{-1} of butene-1, *cis*-butene-2, *trans*-butene-2, and 2-methylpropene were made on flowing vapours. All show a broad intense band which is most intense in the case of the *cis*-isomer, and superimposed systems of narrow bands, both at shorter and longer wavelengths. Whereas the position of the last named is dependent on the number of alkyl groups adjacent to the double bond, the broad band maximum is not similarly displaced but rather depends on the molecular shape and seems related to the dipole moment vector. The vibrational structure of the bands is consistent with infrared and Raman data. A.

535.345

6495. Effect of temperature on light absorption in thin and extra-thin layers of silver. A. G. GUMENYUK. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 4, 783–6 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-171.

Absorption measurements of Ag films on quartz in the range 4000–7000 Å show a number of peaks which correspond to those of photochemically coloured AgCl; this confirms that in both cases absorption is due to colloidal Ag particles. Growth of Ag particles by heating the films or by photo-discoloration of AgCl causes similar shifts in the peaks. G. F. LOTHIAN

535.345 : 539.234

6496. Light absorption and electrical properties of strongly-disordered CdO layers. H. DUNSTÄDTER. *Z. Phys.*, **137**, *No.* 3, 383–5 (1954) *In German.*

The heat-treating temperature of cathode-sputtered CdO films is found to influence the absorption limit for the films and also the electrical properties. The tail absorption is due to the defects produced by the heat treatment. C. A. HOGARTH

535.345 : 771.5

6497. A generalized equation for the transformed density function. É. E. VAĬNSHTEĬN. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 4, 723–5 (1953). English translation, *U.S. Nat. Sci. Found. NSF-tr*-205.

A function is sought of the transmittivity T of photographic emulsions used in recording spectra, which will be linearly dependent on the logarithm of the line-intensity over a wide region of the spectrum. It is shown that several formulae previously proposed for various spectral regions can all be developed from the function $\log [T^{-1}(1 - T)^n]$, where $n \simeq a + A/D^2$ ($A \ll a$), D being the optical density. A. J. TAYLOR

535.345–15

6498. Anomalous optical absorption limit in InSb. E. BURSTEIN. Letter in *Phys. Rev.*, **93**, 632–3 (*Feb.* 1, 1954).

The shift in absorption edge from 7 to 3·2 μ for increasing impurity is explained by assuming very low values for the effective masses of holes and electrons. It is then shown that InSb becomes degenerate at fairly low electron concentrations. The numerical calculations based on this agree very well with experiment. C. A. HOGARTH

535.345–15 : 535.323

6499. On the optical properties of indium phosphide in the infrared. F. OSWALD. Note in *Z. Naturforsch*, **9a**, 181 (*Feb.*, 1954) *In German.*

Indium phosphide shows an absorption edge at about 1 μ with transparency up to 14 μ. The refractive index is ~3 over this range and is sensibly constant. G. F. J. GARLICK

535.345–31

6500. The absorption of light by thallium vapour on the short wave-length side of the series limit. G. V. MARR. *Proc. Roy. Soc. A*, **224**, 83–90 (*June* 9, 1954).

Measurements of the absorption of light in thallium vapour from the series limit at 2030 to 1450 Å are described. The absorption cross-section at the series limit is $4{\cdot}5 \pm 0{\cdot}8 \times 10^{-18}$ cm^2 and the f-number for the continuum over the range of the experiment is $0{\cdot}025 \pm 0{\cdot}005$. Auto-ionization lines are obser at 2007, 1610 and 1490 Å in agreement with th reported by Beutler and Demeter (1934). moderately sharp line at 2007 Å ($^2P^0_{\frac{1}{2}} \rightarrow {}^4P_{\frac{3}{2}}$) has f-number of $0{\cdot}005 \pm 0{\cdot}001$ and a lifetime of 1 5×10^{-15} sec, while the broad line at 1610 Å ($^2P^0_{\frac{1}{2}} \rightarrow {}^2$ has an f-number of $0{\cdot}52 \pm 0{\cdot}09$ and a lifetime $2{\cdot}2 \pm 0{\cdot}1 \times 10^{-15}$ sec. The 1490 Å line ($^2P^0_{\frac{1}{2}} \rightarrow {}^2P_{\frac{3}{2}}$ sharp and the f-number is estimated to be of the sa order as that of the line 2007 Å. These results discussed in relation to the auto-ionization selec rules and previous experimental and theoretical w is reviewed.

535.34

6501. Continuous flow cell for absorption measurements on solutions which fade. G. P. COOKE. *J. Instrum.*, **31**, 180–1 (*May*, 1954).

The cell is designed to reduce errors in absorpt measurements caused when the solution is one wh fades. An approximate calculation, based on rate of fading of the solution, is also given wh enables an estimate to be made of the effectiveness the device at different rates of flow.

535.345.6 : 535.3

6502. The calibration of step-filters for spect analysis by means of photoelectric meters. F. HE MANN, V. CAIMANN AND C. LEYBOLD. *Z. w Photogr.*, **48**, *No.* 10–12, 263–8 (1953) *In German.*

The use of an R.C.A. 931A photomultiplier as li meter, in conjunction with a fluorescent (sodi salicylate) screen, for spectrophotometry of H-lamp continuum in the wavelength band 2200 4500 Å is described. The results obtained from calibration of a Fuess 6-step neutral filter, placed front of the spectrograph slit, are presented discussed. D. R. BAR

535.347

6503. Infrared dichroism in the 13·8 μ band of n-$C_{36}H_{74}$ single crystals and polyethylene. S. KRI Letter in *J. chem. Phys.*, **22**, 567–8 (*March*, 1954).

The 720 cm^{-1} and 730 cm^{-1} bands were vestigated, and it was found that the two compone were due to in-phase and out-of-phase rock motions of the CH_2 groups on neighbouring cha as was indicated by theoretical consideratio Single crystals of $C_{36}H_{74}$ were grown from a isopropyl ether solution: the c axis of the crystal perpendicular to the plane of the crystal plates. E component of the band was almost complet polarized along one crystallographic axis: 720 cm^{-1} band along the b axis and the 730 cm band along the a axis. Heat relaxation of a stretch sample caused crystallites to disorientate in such way that the 730 cm^{-1} component showed para polarization. The same type of preferred orientat was found in machine-extruded polyethylene fil The a axis lay along the machine direction, as v confirmed by X-ray photographs. A. J. TAYL

535.

6504. Ageing of liquid scintillators. M. AGE G. CORTELLESSA AND R. QUERZOLI. *R.C. Ist. Sup Sanita*, **16**, *Pt IV–V–VI*, 211–16 (1953) *In Italian.*

A process of chemical alteration which takes pl during the course of time in solutions of naphthal

xylol is described, a process which completely changes the fluorescence curve as a function of the concentration. This process is of interest in connection with liquid scintillation counters. A.

535.371

6505. Kinetics of luminescence of silver halide salts. A. ARKHANGEL'SKAYA AND P. P. FEOFILOV. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 5, 1055–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-173.

For AgCl and AgBr at 90°K build up and decay processes occur of up to 10^{-3} sec duration and are hyperbolic in form and dependent on excitation intensity. The decay becomes more rapid as temperature increases and in the thermal quenching region approximates to exponential form. In AgI two distinct processes are distinguished with time constants of $\sim 10^{-6}$ or 10^{-5} sec and 10^{-4} sec respectively. The results suggest a predominance of recombination kinetics in the luminescence decay of silver halides.

G. F. J. GARLICK

535.371

6506. An inorganic luminescence reaction. G. GATTOW AND A. SCHNEIDER. Letter in *Naturwissenschaften*, **41**, *No.* 5, 116 (1954) *In German.*

Bubbling fine bubbles of chlorine or bromine through alkaline solutions containing hydrogen peroxide yields a red luminescence visible in daylight.

J. EWLES

535.371

6507. Recent advances in theory of scintillation phosphors. R. K. SWANK. *Nucleonics*, **12**, 14–19 (*March*, 1954).

Current views on the mechanism of the scintillation process in organic crystals, and in liquid and solid solutions, are reviewed. Experimental evidence is given, indicating that the transfer of energy from a solid polystyrene solvent to the fluorescent solute is mainly non-radiative. Possible methods of energy transfer, the mechanism of self-quenching and theories accounting for the dependence of scintillation efficiency upon the specific energy loss of the ionizing particle, are described. Some properties of important phosphors are tabulated. Data showing that decay-time measurements are dependent upon the size of the scintillating sample, are quoted. L. R. SHEPHERD

535.371

6508. Energy transfer from solvent to solute in liquid organic solutions under ultraviolet excitation. L. G. COHEN AND A. WEINREB. Letter in *Phys. Rev.*, **93**, 1117 (*March* 1, 1954).

By using *p*-terphenyl in benzene, toluene or xylene solutions excited by 2537 Å, transfer of energy absorbed in the solvent to the solute molecules occurs in a similar manner to that well known for γ-ray excitation. G. F. J. GARLICK

535.371

6509. Energy transfer by means of collision in liquid organic solutions under high energy and ultraviolet excitations. M. FURST AND H. KALLMANN. *Phys. Rev.*, **94**, 503–7 (*May* 1, 1954).

Experiments are described which show that energy transfer by means of "collisions" occurs when a liquid organic solution is excited by ultraviolet light as well as by high-energy radiation. With light excitation the possibility of any transfer by ionization and/or by hidden radiation could be completely eliminated. It was found that energy transfer by way of collision between various molecules under excitation by light is of the same magnitude as with high-energy radiation excitation. Energy transfer by way of absorption and subsequent re-emission occurs only in complex solutions containing at least two kinds of efficient fluorescent molecules. Basically the technique of the experiments with light consisted of irradiating different solutions with various wavelengths, thereby selectively exciting various components of the solutions, and of observing the corresponding effects on the fluorescent light output. The solutions measured in this investigation used xylene and cyclohexane as solvents; anthracene, *p*-terphenyl and 9, 10-diphenylanthracene as fluorescent solutes; and additional naphthalene which in some respects behaves like a solvent when present in large concentrations. In complete agreement with results under γ-ray excitation, energy transfer under light excitation takes place from naphthalene to anthracene and diphenylanthracene, and from xylene to terphenyl, while none occurs from naphthalene to terphenyl. A.

535.371

6510. Fluorescence of organic single crystals at low temperatures. III. Fluorene. M. BARBARON AND P. PESTEIL. *C.R. Acad. Sci.* [*Paris*] **238**, 1400–2 (*March* 29, 1954) *In French.*

For Pt II, see Abstr. 1197 (1954).

535.372

6511. Interferometric analysis of the fluorescence spectrum of iodine vapour. C. MALAMOND AND H. BOITEUX. *C.R. Acad. Sci.* [*Paris*] **238**, 778–80 (*Feb.* 15, 1954) *In French.*

535.375.5

6512. Apparatus for automatic recording of the Raman spectra. H. LUTHER AND G. BERGMANN. *Chem.-Ingen.-Tech.*, **25**, 499–504 (*Aug.–Sept.*, 1953) *In German.*

Describes in detail a new apparatus enabling the Raman spectra to be directly recorded by means of a photoelectric method. F. LACHMAN

535.375.5 : 535.343–15

6513. Appendix: The assignments of the Raman and infrared frequencies of 1, 2-dichloroethane observed in the gaseous, liquid, and solid states. I. NAKAGAWA AND S. MIZUSHIMA. *J. chem. Phys.*, **22**, 759 (*April*, 1954). See Abstr. 3326 (1954).

535.375.5 : 539.132

6514. Raman intensities of the totally symmetric vibrations of neopentane. D. A. LONG, A. H. S. MATTERSON AND L. A. WOODWARD. *Proc. Roy. Soc. A*, **224**, 33–43 (*June* 9, 1954).

It is pointed out that, on account of their high symmetry, the A_1 modes of vibration of neopentane are specially favourable for testing bond-polarizability theories of Raman intensities. A normal co-ordinate treatment of these modes is given and a modified bond-polarizability theory is applied to the observe relative Raman intensities. It is shown that the derivative of the mean molecular polarizability with

respect to the symmetrical deformations of the methyl groups must be small relative to the derivatives with respect to bond-stretchings. Thus for these modes the simple bond-polarizability theory, involving Wolkenstein's assumption (1941) that the polarizability of a bond is not affected by changes in the bond orientation, represents a good approximation.

A.

535.375.5 : 539.133

6515. Raman spectrum and molecular structure. Study of the series of chlorobromides, chloroiodides and bromoiodides of silicon, germanium IV and tin IV. M. L. DELWAULLE, M. F. FRANÇOIS AND M. DELHAYE-BUISSET. *J. Phys. Radium*, **15,** 206–8 (*March*, 1954) *In French.*

These molecules are all tetrahedral. Raman spectra were taken. The position of ν_1, varying from 150 to 500 cm^{-1} for the different compounds is a good guide for identification. When two such compounds are mixed, there occurs an exchange reaction which leads to an equilibrium. The change of the Raman spectrum of the mixture in time gives a good indication of the reaction rate and the final products.

A. J. TAYLOR

535.375.54 : 539.132

6516. On the effect of the hydrogen bond on Raman spectrum. A. I. STEKHANOV. *Dokl. Akad. Nauk SSSR*, **92,** *No.* 2, 281–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-189.

Raman spectra of gypsum were obtained from the resonance time of mercury, 2537 Å. Spectra and microphotometer curves of the 3500 cm^{-1} region at 20°C and at −200°C are reproduced. These show that the band corresponding to valence vibrations of the OH group in the crystal has fine structure, the observed details being explicable by the theory of the hydrogen bond of Stepanov. It is suggested that only the lines at 110, 122, 132 and 146 cm^{-1} belong to the hydrogen band spectrum. The lines with frequencies 3408 and 3486 cm^{-1} are OH bond frequencies. There is good agreement between observed and calculated combination frequencies of these with the hydrogen bond lines.

A. J. TAYLOR

535.375.55

6517. The Raman spectra of solutions of pyridine and of acetic acid. I. R. MIERZECKI. *Acta phys. Polon.*, **12,** *No.* 1, 26–31 (1953) *In French.*

The observed Raman spectra of pyridine, acetic acid, and of mixtures of these two substances containing 61·0, 48·3, 41·4, 30·4 and 22·3% pyridine molecules are presented in graphical and tabular form. The spectra of the mixtures exhibit feeble displacements of the lines observed for the pure substances, and two new bands of frequencies $\Delta\nu = 881$ cm^{-1} and 1005 cm^{-1} are recorded which do not appear in the spectra of the pure compounds.

G. I. W. LLEWELYN

535.375.56

6518. High resolution Raman spectroscopy of gases. I. Experimental methods. B. P. STOICHEFF. *Canad. J. Phys.*, **32,** 330–8 (*May*, 1954).

An apparatus for obtaining intense Raman spectra of gases excited by the Hg 4358 line is described. It consists of a mirror-type Raman tube irradiated b two high-current mercury lamps, completely enclose in a reflector of magnesium oxide. The lamps a externally water-cooled along their entire length an emit sharp lines of high intensity. Rotational Rama spectra of gases at a pressure of 1 atm. have bee photographed in the second order of a 21 ft grating i exposure times of 6 to 24 hr. The Raman lines a sharp and a resolving power of about 100 000 has bee achieved. It will be possible to resolve the rotation Raman spectra, and hence to evaluate the rotation constants of molecules having moments of inertia up to 300×10^{-40} g. cm^2. Such investigations will b especially useful for non-polar molecules.

535.3

6519. Slow component in decay of fluors. F. HARRISON. *Nucleonics*, **12,** 24–5 (*March*, 1954).

The decay of light from scintillation crystals, pla tics and solutions, over periods from 0·1 to a fe hundred μsec after termination of the excitatio was investigated. The phosphors were excited b 70 kV X-rays and observed with a photomultipli free from afterpulsing. The X-ray tube was switche on for a period long enough for slow components light emission to reach equilibrium. It was the gated-off while the photomultiplier was gated-o There were no observable delayed components in th light emitted from solutions, but in organic crysta and plastic phosphors significant fractions of the lig were emitted with decay periods ranging from 0· to 110 μsec and in NaI a slow component with perio between 1 and 13 sec was observed. L. R. SHEPHER

535.3

6520. Calculation of electron trap depths fro thermoluminescence maxima. A. H. BOOTH. *Cana J. Chem.*, **32,** 214–15 (*Feb.*, 1954).

The Randall–Wilkins single trap depth glow cur formula [Abstr. 757 (1946)] is differentiated and i maximum derived. By using results of two differe heating rates the frequency factor s can be eliminate and the trap depth found. G. F. J. GARLIC

535.39 : 522

6521. Multilayer coatings of high efficiency and the applications for astrophysical research work. A. I JARRETT. *Z. Astrophys.*, **34,** *No.* 2, 91–8 (1954).

A comparison is made of the merits of multilay coatings as opposed to silver films for high resoluti interferometry. It proved possible to produce diele tric coatings with an absorption coefficient of on 1% for a reflection coefficient of 94%; for a reflecti coefficient of 97% an enhanced silver film gave a absorption of 1·5%. Taking into account th excellent keeping properties of the dielectric films th conclusion is that they are superior to silver film Applications to solar and auroral interferometry a described.

535.39 : 539.2

6522. The reflection of light from glass with a thi metallic film. A. VAŠÍČEK. *Czech. J. Phys.*, **3,** *No.* 126–36 (1953).

Deduces the correct formula for the reflection light on a thin metallic film by the generalizing of th well-known formula for the reflection of light on

in transparent film deposited on glass. The deduced ormula is in accordance with a simple consideration bout the energy relationship in a reflected light. In ne second part the optical coherence between the eflection of light from two thin transparent films and ne reflection from a thin metallic film is discussed. A.

535.391

6523. Reflection and transmission spectra of potassium-silicate glasses in the infrared. V. A. FLORINSKAYA AND R. S. PECHENKINA. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1, 59–62 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-108.

Reflection spectra were investigated with surfaces freshly polished with rouge and kerosene; transmission spectra on fine films, a few μ thick, drawn out of the melt. All glasses investigated (K content 15–35%) show a transmission band corresponding to one of the active atomic oscillations in the SiO_4 tetrahedron, and another corresponding to the pulsation of the SiO_4 tetrahedron. The degree of polymerization of the SiO_4 tetrahedra decreases as the K-ion content increases. Reflection experiments show that, during heat treatment, the growth occurs of zones with an ordered atomic arrangement. F. LACHMAN

535.391

6524. Reflection spectra of ordinary and devitrified lead glasses in the infrared. V. A. FLORINSKAYA. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 2, 261–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-50.

Presents the results of an investigation on the reflection spectra of lead glasses [see also Abstr. 6645 (1953)] both with and without devitrification caused by heat-treatment. A mirror monochromator spectrometer with a NaCl prism, and a thermopile were used. The curves for the ordinary and devitrified glass are very similar. The simplest reflection curves of devitrified glass have been obtained for glasses with, or near, the composition $2PbO.SiO_2$. The curves become more complex as the SiO_2 content increases. Starting from 55% PbO downwards, a reflection band appears near $12{\cdot}6\,\mu$, caused by regular rings of tetrahedra. Some devitrified glasses show features of reflection curves for Pb metasilicate and orthosilicate. F. LACHMAN

535.391

6525. Reflection spectra of compound silicate glasses in the infrared before and after thermal treatment. V. A. FLORINSKAYA. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 6, 1011–14 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-148.

Presents the results of the study of the reflection of optical glasses subjected to a long heat treatment at different constant temperatures. It is deduced from the existence of some maxima of the reflection bands that the flint glass (initial, and heated to 495 or 620°c) has zones of free SiO_2 with an ordered arrangement of atoms and in the form of either α- and β-quartz or α-quartz and cristobalite. Other maxima in heavy optical flint glasses and in Pb glass (Pb content = 35%) point to the presence of crystallites of Pb silicates in the glass. Two or more types of SiO_2 crystallites coexist in heated heavy flint glasses. F. LACHMAN

535.392

6526. The origin of the colours in precious opal. C. V. RAMAN. *Curr. Sci.*, **22**, 355–8 (*Dec.*, 1953).

Presidential Address to the Indian Academy of Sciences.

535.392

6527. The structure and optical behaviour of iridescent shells. C. V. RAMAN AND D. KRISHNAMURTI. *Proc. Indian Acad. Sci. A*, **39**, 1–13 (*Jan.*, 1954).

Some remarkable optical effects exhibited by nacreous shells have been observed and reported, the following amongst others: The monochromatic reflections and extinctions split into two polarized components at oblique incidences as a result of the birefringence of the material. Light traversing the stratifications obliquely suffers extinction by reason of diffusion by the crystallites of aragonite, this being most rapid for the component of vibration in the plane of incidence. Striking changes are also observed in the character of the diffusion haloes with increasing obliquity of observation, a particularly noteworthy feature being that the different parts of the diffusion field are differently polarized. A.

535.417 : 621.389 : 621.374.32

6528. Electronic fringe interpolator for an optical interferometer. R. D. HUNTOON, A. WEISS AND W. SMITH. *J. Opt. Soc. Amer.*, **44**, 264–9 (*April*, 1954).

Provision is made for automatic counting of integral fringes, interpolation to within 1/200 wavelength or approximately 10^{-7} in., and indication of the direction of motion of the interferometer plates. Automatic interpolation is achieved by vibrating one plate of the interferometer and analysing the resulting a.c. signals from a photomultiplier exposed to a portion of the fringes in the image plane of the optical system. The use of an a.c. analyser eliminates troublesome d.c. drifts associated with photoelectronic circuits and provides an oscilloscope display of the phase progression from fringe to fringe. A.

535.42

6529. A simple derivation of the expression for the Kirchhoff diffraction wave. A. RUBINOWICZ. *Acta phys. Polon.*, **12**, *No.* 3–4, 225–9 (1953) *In German.*

The expression derived by the author in 1917 [*Ann. Phys.* (*Leipzig*) **53**, 257–78 (Dec. 14, 1917)] for the field produced by a point source of light and a screen has found extensive application. The present paper gives a very simple derivation of it.

P. M. DAVIDSON

535.42

6530. Determination of the best super-resolving pupil of four concentric rings. M. T. ZOLI. *Atti Fond. Ronchi*, **9**, 41–3 (*Jan.–Feb.*, 1954) *In Italian.*

The analysis of the diffraction patterns given by super-resolving pupils is further developed [see Abstr. 3182 (1953)]. The present investigation deals with the case of a pupil presenting four concentric annuli of different transparency and phase. A.

535.42 : 534.23

6531. Diffraction of light due to several ultrasonic waves. R. R. AGGARWAL AND S. PARTHASARATHY. *J. sci. industr. Res.*, **12 B**, 459–62 (*Oct.*, 1953).

Intensity expressions correct to the second-order

approximation have been obtained for lines in the diffraction pattern obtained when a beam of light is passed through a liquid agitated by several ultrasonic waves. In the case of combination lines, the theoretical values for the ratio of intensities of inner combination lines to the intensities of the outer combination lines agree qualitatively with the ratios obtained experimentally. A.

535.42 : 538.566

6532. Variational principles in the mathematical theory of diffraction. A. Erdélyi. *Atti Accad. Sci. Torino, I*, **87**, 281–93 (1952–53).

The author re-formulates Rayleigh's approximation for the diffraction of a long wave on a finite plane screen, obtaining a variational problem. He shows that the variational methods recently introduced in diffraction theory by Levine and Schwinger are the natural extensions to higher frequencies of Rayleigh's approximation, and that these methods may be presented in such a manner as to be suitable for the analysis of a field at any given point, due to an arbitrary incident wave. A.

535.421

6533. Diffraction gratings in immersion. E. Hulthén and H. Neuhaus. Letter in *Nature* [*London*] **173**, 442–3 (*March* 6, 1954).

The resolving power of diffraction gratings ought to be increased by immersing the grating in a medium of high refractive index. This letter reports two methods of achieving this increased resolution and illustrates the considerable gain achieved in practice. R. W. FISH

535.434 : 535.51

6534. Effect of convergence on depolarisation measurements in colloid scattering. K. Vijayaraghavan and R. S. Krishnan. *J. Indian Inst. Sci. A*, **36**, 1–9 (*Jan.*, 1954).

The effect of convergence on the three depolarization factors ρ_u, ρ_v and ρ_h has been investigated in the case of five different colloidal solutions. It is observed that while the values of ρ_u and ρ_v increase with the angle of convergence irrespective of the nature of the colloid, the value of ρ_h decreases with the angle of convergence in those cases where the particle size is very small compared with the wavelength of light, i.e. corresponding nearly to the case of molecular scattering. For a scattering medium consisting of particles of bigger size, the value of ρ_h is found to increase with the angle of convergence. The convergence errors of ρ_u, ρ_v and ρ_h for a colloid are found to be much larger than those given by Ananthakrishnan's formulae for molecular scattering. The actual values of the errors depend not only on the angle of convergence but also on the nature of the colloidal medium under investigation. A.

535.437

6535. Opalescence and concentration fluctuations in binary liquid mixtures near the critical mixing point. I. Experimental. C. Quantie. *Proc. Roy. Soc. A*, **224**, 90–104 (*June* 9, 1954).

This investigation deals with the measurement of the coherent scattering of light in binary liquid mixtures near the critical mixing point, usually called "critical opalescence," which is due to fluctuations of concentration produced by the thermal molecula movement. The apparent extinction of the incider light beam and the angular distribution of th scattered light intensity was measured by a photo electric method over a wide range of wavelengths i the visible and ultraviolet region and a range temperatures above the critical point for nine suitab selected liquid mixtures. It was found that tho could be grouped into two classes, each of which characterized by a specific law of temperature an wavelength dependence of the transmitted an transversely scattered light intensity and a specif shape of the angular distribution of scattered light.

535.4

6536. Opalescence and concentration fluctuations binary liquid mixtures near the critical mixing poin II. Theoretical. R. Fürth and C. L. William *Proc. Roy. Soc. A*, **224**, 104–119 (*June* 9, 1954).

A theory of light scattering in fluids produced b local fluctuations of refractive index is develope from the theory of X-ray scattering in fluids which applied to the phenomena of critical opalescence one-component liquids due to density fluctuation and in two-component liquid mixtures due to co centration fluctuations. The dependence of th scattered light intensity on wavelength and scatterin angle can be derived from the theoretical expressio when the correlation of the fluctuations in two volum elements as a function of the distance of these elemen is known. The theory is used for determining th shape of the correlation function for a number binary mixtures from the measured angular distrib tion of the scattered light intensity, as described Pt I by means of numerical computation of Fouri integrals. It is found that the mixtures belonging Class I (as defined in Pt I) are characterized by correlation function with a range of negative correl tion, and those belonging to Class II by a correlatio function of nearly Gaussian shape. The absolu magnitude of the concentration fluctuations near th critical mixing point is also calculated from th observational material. A tentative qualitativ explanation for the different shapes of the correlatio function for the two classes of mixtures is presente

535.2

6537. Two half-shade devices for optical polarizin instruments. F. H. Smith. Letter in *Nature* [*Londo* **173**, 362–3 (*Feb.* 20, 1954).

The first method forms two virtual images of wire by double refraction, the wire diameter bein chosen equal to the displacement so that a very shar boundary between the images is formed. Th alternative method uses the mutually differen polarizations resulting from reflection at surface which are partly metallized and partly totall reflecting. Practical details of the use of both metho are given. R. W. FIS

535.5

6538. Interpretation of photoelastic transmissio patterns for a three-dimensional model. D. C Drucker and W. B. Woodward. *J. appl. Phys* **25**, 510–12 (*April*, 1954).

The work of O'Rourke and Saenz on the photo elastic determination of quenching stresses i

-examined and extended. A brief general discussion given on the determination of shear stresses or ress differences in the interior of a photoelastic odel from retardation patterns obtained by passing ght through the entire model. A method is proposed or the cylindrical case, with no variation in stress long the axis, which is feasible at present, while the roposal for the general axi-symmetric problem is easible in principle. The fundamental difficulty of e general three-dimensional model is brought out ut no solution is advanced. A.

535.55

6539. Gauge for photoelastic stresses. R. FLEURY AND F. ZANDMAN. *C.R. Acad. Sci.* [*Paris*] **238,** 559–61 (*April* 12, 1954) *In French.*

A gauge is described analogous to the resistance train gauge. A layer, about 1 mm thick, of a substance which shows birefringence under strain is deposited on a prepared surface of the object under test. The surface needs to be reflecting: a suitable substance is an ethoxy resin with a photoelastic constant of about 50 brewsters. The object is strained and linearly polarized light is passed through the layer where it is reflected and the birefringence induced in the layer found by the Tardy method or a Babinet compensator. Accuracy is about 4%. The method is useful for investigating plastic flow and fatigue.

H. G. JERRARD

535.56

6540. Anomalous rotatory dispersion of quartz above 3·7 μ? C. D. WEST. Letter in *J. chem. Phys.*, **22,** 749–50 (*April*, 1954).

The conclusion of Gutowsky [Abstr. 4314 (1951)] that quartz exhibits a real anomalous rotatory dispersion beginning at 3·68 μ and extending to at least 9·71 μ is questioned. From a study of his results and those of Lowry and Snow [*Proc Roy. Soc. A*, **127,** 271 (1930)], Drummond [*Proc. Roy. Soc. A*, **153,** 318 (1936)], Stein [*Ann. Phys.* (*Leipzig*) **36,** 462 (1939)] and Ingersoll *et al.* [*Phys. Rev.*, **57,** 1145 (1940)], it is suggested that above 4 μ Gutowsky had insufficient spectrally pure energy available to make accurate readings and that the presence of stray radiation falsified the results. It is concluded that the rotation of quartz is reliably known only up to and including Gutowsky's value of 0·34 ± 0·02 deg. mm^{-1} at 3·676 μ. The method described of reaching this conclusion is recommended for testing the plausibility of measurements of any property of specularly transmitted radiation.

H. G. JERRARD

535.7 : 612.84

Physiological optics. *See Abstr.* 7066–9

535.822.17

6541. The phase-contrast microscope and the interference microscope. M. FRANÇON. *Paris: Editions du Centre National de la Recherche Scientifique* (1954) 150 *pp. In French.*

This book arises from a series of lectures given in Rio de Janeiro during a seminar on microscopy. The first part deals fully with the theory of image formation with both point and extended objects. The theory and practice of phase and interference microscopy form the second part, and this contains very detailed information on modern equipment and its use. The application of these techniques to biology, chemistry, etc., is described and well illustrated by 10 photos and 1 colour plate. A particularly valuable feature is the extensive and up-to-date bibliography (22 pp.).

R. W. FISH

535.824.2

6542. The correction of microscope objectives of low power. I. J. CASAS AND J. BARCALA. Note in *An. Real. Soc. Espan. Fis. Quim.*, **49(A)** 343–6 (*Nov.–Dec.*, 1953) *In Spanish.*

The author discusses the design of a low powered (×7) microscope objective. Curves of spherical aberration and coma are given for five combinations of optical glass and the most suitable pair of glasses is deduced for a simple doublet objective. R. W. FISH

535.824.2

6543. A simple form of flat field microscope objective. W. S. S. BLASCHKE. *J. sci. Instrum.*, **31,** 173–4 (*May*, 1954).

An objective is described in which the minimum additional complications in design are introduced. This allows the retention of high numerical aperture while considerably extending the useful field. A.

535.825.2

6544. A microscope stage and integrating point counter for micrometric analysis of rocks. I. H. FORD. *J. sci. Instrum.*, **31,** 164–5 (*May*, 1954).

The apparatus described was built for the accurate measurement of the areas occupied by component minerals in thin sections of rocks, and polished sections of opaque ore mineral aggregates. The point counting method of analysis is used. Each point corresponds with an electrical pulse which is produced and recorded automatically. A.

535.89

6545. Control techniques for rapid events. F. FRÜNGEL. *Z. angew. Phys.*, **6,** *No.* 4, 183–92 (1954) *In German.*

Describes controlled spark and photo-flash-tube techniques for the observation of short-lived phenomena, mainly in the field of mechanical engineering. High-speed stroboscopic techniques are also treated. The times involved vary down to a few microseconds. J. D. CRAGGS

535.89 : 537.525.5

6546. On the light intensities of small-type spectral lamps. III. H. TAKEYAMA, T. KITAHARA AND K. NISIMOTO. *J. Sci. Hiroshima Univ. A*, **16,** 525–9 (*May*, 1953).

An experimental investigation of the voltage-current and light-emission time characteristics of low pressure sodium lamps of a commercial type. The lamps were operated in a resistive d.c. circuit. The effect of a weak magnetic field was briefly investigated.

J. D. CRAGGS

535.89 : 537.525.5

6547. On the light intensities of small-type spectral lamps. IV. H. TAKEYAMA, K. NISIMOTO, T. MATUBAYASI AND T. KITAHARA. *J. Sci. Hiroshima Univ. A*, **16,** 531–4 (*May*, 1953).

An investigation of the oscillations in the light intensity-time curve for low-pressure discharge lamps.

The effects of such parameters as circuit resistance and capacitance were studied. J. D. CRAGGS

535.89 : 537.525.5

6548. On the light intensities of small type spectral lamps. V. With special reference to the change of the wave form. T. MATUBAYASI. *J. Sci. Hiroshima Univ. A*, **17**, 121–3 (*Aug.*, 1953).

Further brief studies of the relaxation-oscillation effects obtained with capacitance-shunted low-pressure hot-cathode discharge lamps. J. D. CRAGGS

HEAT 536

536.2 : 532.72

Symmetry as a factor in finite difference diffusion approximations. *See Abstr.* 6337

536.2.083

6549. A new method for the absolute measurement of the thermal conductivity of small samples. J. BEDNÁŘ. Letter in *Czech. J. Phys.*, **3**, *No.* 2, 170–1 (1953) *In Russian.*

Discusses the theory of a modification of the Forbes bar type of experiment. J. M. HOUGH

536.23 : 533.72

Heat conduction in a rarified gas. *See Abstr.* 6362

536.24

6550. On the theory of heat transfer in parallel oil layers. II. B. DIZIOĞLU. *Rev. Fac. Sci. Univ. Istanbul A*, **17**, 259–81 (*July*, 1952) *In German.*

For Pt I, see Abstr. 6703 (1953). The eigenvalue equations of the problem introduced in Pt I are deduced for the cases $0 < q < 1$ and $q = 1$. The eigenvalues are numerically calculated for $q = \frac{1}{4}, \frac{1}{2}, 1$. The Fourier–Bessel coefficients of the eigenfunction expansions are then determined for $q = \frac{1}{2}, 1$. Using the final solutions, the temperature distribution for the two most important cases, $q = \frac{1}{2}$ and $q = 1$ is calculated and drawn. T. P. BRODY

536.24

6551. Heat transfer in liquid non-conductors under the effect of electric fields. E. SCHMIDT AND W. LEIDENFROST. *Chem.-Ingen.-Tech.*, **26**, 35–8 (*Jan.*, 1954) *In German.*

An apparatus described in detail was used for the investigation of the coefficient of heat transfer of different liquids. The apparatus enables a high-voltage electric field to be applied. It was found that the thermal conductivity in a constant-voltage field is 2–5 times that for normal conditions. Schlieren photographs show that this conductivity rise is due to the convection within the liquids. F. LACHMAN

536.242 : 532.54

6552. Heat loss of fluids flowing through conduits. J. SCHENK. Letter in *Appl. sci. Res. A*, **4**, *No.* 3, 222–4 (1954).

V. J. Berry's [Abstr. 5527 (1954)] consideration of the heat loss from a hot liquid is discussed in the light of the author's work. Values of the inside Nusselt number as a function of the outside Nusselt number for Poiseuille flow between parallel plates and in circular cylindrical tubes in the thermally established region have been calculated and are shown graphically alongside those of Berry for slu flow. The results are stated to be of some physica interest but little practical importance. S. WEINTROU

536.413 : 548.736.1 : 548.73

Coefficients of expansion of γ- and δ-manganes *See Abstr.* 7017

536.413.2 : 537.31

Expansion coefficient, density and transition tem peratures of metallic plutonium. *See Abstr.* 6594

536.421.1.0

6553. An apparatus for the determination of th solidus temperatures of high-melting alloys. R. A ORIANI AND T. S. JONES. *Rev. sci. Instrum.*, **25** 248–50 (*March*, 1954).

An apparatus has been developed for the dete mination of the melting temperatures of alloys up t 2200°c, which attains blackbody conditions for th temperature measurements and precludes the poss bility of contamination from a refractory containe Its operation has been checked by melting gold, nicke iron, titanium, platinum, zirconium and rhodiu with an average reproducibility of ±5 deg. and a average deviation from the recognized melting poin of 5 deg. c. The melting point of pure vanadium ha been determined as 1919 ± 2°c.

536.421.4 : 536.76

6554. Lowering of the freezing point of wate confined in cylindrical and spherical vessels. M. SATÔ S. FUJITA AND T. KAJIMA. *J. Sci. Res. Inst.* [*Toky* **47**, 119–27 (*Dec.*, 1953) *In German.*

The water, frozen symmetrically from outwards, found to obey the Clausius-Clapeyron equation.

T. P. BROD

536.423.1

6555. A new universal vapour-pressure formul Widening of the theorem of corresponding states. L. RIEDEL. *Chem.-Ingen.-Tech.*, **26**, 83–9 (*Feb.*, 195 *In German.*

In accordance with the theorem of correspondin states, the reduced vapour-pressure curves of differe non-associated substances should coincide with eac other. In reality one obtains very nearly a single parameter group of curves. By introducing a "critica parameter" characteristic of a given substance, becomes possible to develop an equation for th group of curves, which enables the whole vapou pressure curve of a substance to be calculated fro its critical temperature and boiling-point. If th vapour pressure at any 2 temperatures is known, it possible to estimate the critical pressure.

F. LACHMA

536.4

6556. Investigations of the "vapor snake" pheno menon. R. VERSCHINGEL AND H. I. SCHIFF. *J. chem Phys.*, **22**, 723–5 (*April*, 1954).

The "vapour snake" phenomenon, originall reported for cyclohexane, has been found to occu with some twenty compounds. The ease of occurrenc increases with the triple point pressure of the com pound. The tubule tip was always at the freezin point of the compound although the surroundin liquid may be above the freezing point. Althoug the presence of a crust on the surface of the liquid i not essential for the occurrence of the phenomenon transport of heat by vapour to a cold portion of th

mple must occur in order to produce a tubule leath of the thickness observed. A.

536.453 : 628.8 : 551.521.1

557. **The present and future utilization of solar nergy.** F. Trombe. *J. Rech. Cent. Nat. Rech. Sci.*, 193–215 (*Dec.*, 1953) *In French.*

The variation of reception of solar energy over the rth's surface and the various ways in which it is tilized are briefly considered. The emphasis is on e artificial methods of using this energy and includes ouse heating by recuperators, water heating and istillation. Methods of concentrating the radiation re examined in detail and modern solar furnaces are escribed and illustrated. An extensive bibliography included. E. H. DOCK

536.46

558. **Theory of laminar flame stability. I. Analytic tability condition.** J. B. Rosen. *J. chem. Phys.*, **22**, 33–42 (*April*, 1954).

The stability of propagation of a laminar flame or ombustion wave is studied for a general type of lame propagating medium. This is done by investiating the stability of the steady-state solution of the lame equations for such a system. The method is o solve the linearized system of partial differential quations resulting from an instantaneous heat release erturbation of the steady-state solution. An pproximate solution in analytic form to this inearized partial system is obtained. This permits he statement of an analytic stability condition, and hows the existence of stability limits. The existence of stability limits is suggested as an explanation of nflammability limits. A.

536.46

559. **Theory of laminar flame stability. II. General numerical method and application to typical system.** N. B. Rosen. *J. chem. Phys.*, **22**, 743–8 (*April*, 1954).

The steady-state flame equations for a system which may include the effect of a free radical are obtained in dimensionless form, and solved for a typical choice of parameter values. A general numerical method for determining the stability of such a system is described. This method is applied to the chosen steady-state solution which is shown to be unstable. The growth of the temperature, concentration and mass-flow perturbations are shown, and the temperature perturbation is compared with that given by the corresponding approximate analytic solution obtained in Pt I. A.

536.48

6560. **Simple equipment and techniques for a small cryogenics laboratory.** N. S. Rasor. *Rev. sci. Instrum.*, **25**, 311–18 (*April*, 1954).

Simple techniques and easily constructed equipment are described for a small cryogenics laboratory utilizing a commercial helium liquefier. Emphasis is placed on simplicity and availability rather than on high accuracy and efficiency in low-temperature work. Accessories for a Collins liquefier and a commercial liquid-helium storage container are described. Techniques used for reaching and measuring intermediate temperatures are outlined, along with a description of two portable cryostats. A small mica and Pyrex platinum resistance thermometer has been developed, and its relatively simple fabrication is described. A.

536.48 : 538.222

6561. **The thermal and magnetic properties of chromium methylamine alum between 0·01 and 1°K.** W. E. Gardner and N. Kurti. *Proc. Roy. Soc. A*, **223**, 542–53 (*May* 20, 1954).

Adiabatic demagnetizations and calorimetric measurements have been carried out with chromium methylamine alum. The results can be interpreted by a Stark splitting of the ^4S ground state of the Cr^{3+} ion of $(0{\cdot}27 \pm 0{\cdot}01)$°K. Absolute temperatures for this salt have been determined down to 0·01°K. The Curie point was found at 0·020°K. A.

536.48

6562. **The log T v. S diagram of helium.** W. H. Keesom, A. Bijl and L. A. J. Monté. *Appl. sci. Res. A*, **4**, *No.* 1, 25–33 (1953) *In French.*

A new diagram covering the fluid region (liquid and gas) from 1–500°K and from 0 to 300 atm. Explanatory details, critical remarks and source references are included. R. O. DAVIES

536.48

6563. **Specific heat of 96-percent He^3 below 1°K.** G. de Vries and J. G. Daunt. Letter in *Phys. Rev.*, **93**, 631–2 (*Feb.* 1, 1954).

Previous measurements of the specific heat at saturation [Abstr. 5557 (1954)] are extended beyond 1·3 down to 0·57°K. The specific-heat curve as previously obtained can be continued so that it is fitted to the new measurements. There is no indication of a λ-point or any other discontinuity, but the specific-heat curve becomes so flat that there is no obvious way of extrapolating it to absolute zero. Between 0·57 and 1·7° the specific heat is smaller than that calculated for an ideal Fermi–Dirac gas; there is, apparently, at these temperatures no excess specific heat due to alignment of nuclear spins. By correcting for the 4% of He^4, an entropy-temperature curve appropriate to pure He^3 is derived; it is found that this curve has a point of inflection at 1·25°. R. EISENSCHITZ

536.48

6564. **Feynman's theory of liquid helium.** G. V. Chester. Letter in *Phys. Rev.*, **93**, 1412 (*March* 15, 1954).

In the theory of the λ-transition [Abstr. 407 (1954)] Feynman employs unconventional arguments involving quantum-mechanical trajectories. The author shows that equivalent results can be derived by the familiar method of distributions in phase space such as defined by Wigner [*Phys. Rev.*, **40**, 749–60 (*June*, 1932)]. In addition it is shown that approximations introduced by Feynman are virtually identical with Kirkwood's superposition approximation which is frequently applied in the theory of classical liquids. The author points out that Feynman's work was to an appreciable extent anticipated by Matsubara [Abstr. 8134 (1952)]. R. EISENSCHITZ

536.48

6565. **Coefficient of expansion of liquid helium II.** K. R. Atkins and M. H. Edwards. Letter in *Phys. Rev.*, **93**, 1416 (*March* 15, 1954).

Measurements are made at temperatures from 0·85° upward. The coefficient of expansion rises from $0{\cdot}3 \times 10^{-3}$ to a flat maximum, vanishes at 1·12° and

approaches a relatively high negative value at the λ-point. Results are interpreted in terms of Landau's theory, regarding the observed expansion coefficient as a sum of a phonon and a roton contribution. The former is calculated, the latter can be fitted by adapting two numerical parameters. Authors note that there is an approximately linear relation between the roton contribution to the density and the density of the normal component. R. EISENSCHITZ

536.48

6566. The heat of mixing of He^3 and He^4 solutions. V. S. NANDA. *Phys. Rev.*, **94**, 241–3 (*April* 15, 1954).

None of the current theories of He^3 and He^4 solutions is really satisfactory. In order to decide which of these makes the correct approach to the problem, experiments on the heat of mixing can be very useful. It is shown here that various theories predict remarkably different behaviour for this quantity. In particular de Boer and Gorter theory gives rather high values for heat of mixing per mole of He^3. A comparison of the theoretical and experimental results should thus show clearly the need of Taconis hypothesis in explaining the various properties of He^3 and He^4 solutions. A.

536.48

6567. The theory of liquid helium. G. V. CHESTER. *Phys. Rev.*, **94**, 246–52 (*April* 15, 1954).

The free energy, F, of an assembly of interacting helium atoms is expressed in terms of the trace of the density operator, $\exp(-\beta H)$, where $\beta = 1/kT$, H is the Hamiltonian and T the temperature. The Hamiltonian is written as $H_0 + gW$, where H_0 is the part corresponding to the kinetic energy and gW the potential energy. The resulting expression for F is expanded in powers of g, the first two terms of the series being calculated explicitly. The first term, which is independent of g, gives the free energy of the London theory, and leads to all the usual results. In particular the transition at the lambda temperature, T_λ, is of the third order. The second term in the expansion of F raises the transition to one of the second order; all the second-order derivatives of this term are discontinuous at T_λ, while T_λ and $\partial T_\lambda/\partial\rho$ are the same as in the London theory. Numerical values are obtained for the specific heat and the discontinuity in the specific heat. These are compared with experiment and it is found that there is an improvement as compared with previous theories. A.

536.48

6568. Density fluctuations at low temperatures. P. J. PRICE. *Phys. Rev.*, **94**, 257–61 (*April* 15, 1954).

The applicability to a quantum liquid of the standard classical formula connecting the compressibility with the coherent scattering cross-section for large wavelengths, questioned by the author in a previous paper, is examined. The correctness of the standard formula is proved (*a*) at absolute zero (the density fluctuations being infra-normal); (*b*) under quantum conditions for all temperatures at which the Wigner expansion converges (it is conjectured that for liquid helium the expansion may diverge below the lambda-point); and (*c*) for a one-dimensional crystal for all temperatures. These results, while they stop short of a complete proof of the standard classical formula for all conditions, do extend considerably our knowledge of its range of validity.

536.

6569. Atomic theory of the two-fluid model liquid helium. R. P. FEYNMAN. *Phys. Rev.*, **94**, 262– (*April* 15, 1954).

It is argued that the wavefunction representing a excitation in liquid helium should be nearly of the for $\Sigma_i f(\mathbf{r}_i)\phi$, where ϕ is the ground-state wavefunctio $f(\mathbf{r})$ is some function of position, and the sum is take over each atom i. In the variational principle this tri function minimizes the energy if $f(\mathbf{r}) = \exp(i\mathbf{k}\cdot\mathbf{r}$ the energy value being $E(k) = \hbar^2k^2/2mS(k)$, whe $S(k)$ is the structure factor of the liquid for neutro scattering. For small k, E rises linearly (phonons For larger k, $S(k)$ has a maximum which makes a ri in the diffraction pattern and a minimum in the $E($ *v.* k curve. Near the minimum, $E(k)$ behaves $\Delta + \hbar^2(k - k_0)^2/2\mu$, which form Landau found agre with the data on specific heat. The theoretical val of Δ is twice too high, however, indicating need of better trial function. Excitations near the minimu are shown to behave in all essential ways like t rotons postulated by Landau. The thermodynam and hydrodynamic equations of the two-fluid mod are discussed from this view. The view is not adequa to deal with the details of the λ-transition and wi problems of critical flow velocity. In a dilute solutio of He^3 atoms in He^4, the He^3 should move essential as free particles but of higher effective mass. Th mass is calculated, in an appendix, to be about s atomic mass units.

536.48 : 536.

6570. The heat capacity and entropy of liquid H from 0·42°K to 1·06°K. D. W. OSBORNE, B. M ABRAHAM AND B. WEINSTOCK. Letter in *Phys. Rev.* **94**, 202 (*April* 1, 1954).

Results of preliminary specific heat measurement are communicated and discussed. Using vapou pressure data the entropy of the liquid at saturatio pressure and 0·42°K is found to be very nearly equa to $R \ln 2$. Assuming that the phonons do not co tribute appreciably, this value is interpreted as bein due to random orientation of the nuclear spins. Th entropy is appreciably larger than the entropy o an ideal Fermi–Dirac gas at the same volume an temperature. An estimate of the entropy of soli He^3 at 0·42°K is made by using melting pressure dat It is found that the difference in entropy between soli and liquid is fairly small and that the spins a distributed at random also in the solid state.

R. EISENSCHIT

536.4

6571. Theory of diffusion and thermodiffusion i dilute solutions of He^3 in helium II. V. N. ZHARKO AND I. M. KHALATNIKOV. *Dokl. Akad. Nauk SSS* **93**, *No.* 6, 1007–9 (1953) *In Russian.*

The transport equations for He^4 are supplemente with terms arising from the scattering of He^3 atom by other He^3 atoms, by rotons and by phonons Expressions are obtained for the coefficients d diffusion and thermodiffusion as functions of tem perature and concentration; they involve as para meters the effective mass of He^3 and a time constan apart from quantities associated with properties o

ure He^4. The theoretical diffusion coefficient is otted against the temperature. This graph compares vourably with a curve which is derived from known ermal conductivity data and to which it is fitted at ne point. R. EISENSCHITZ

536.48

572. Contribution to the theory of the superfluidity f quantum liquids. B. T. GEĬLIKMAN. *Dokl. Akad. auk SSSR*, **94,** *No.* 2, 199–202 (1953) *In Russian.*

The liquid is represented as a continuum with inetic energy and a potential energy depending on ne density which is to account for the interaction of nolecules. In first approximation the potential nergy expresses ordinary volume elasticity. Using method of second quantization it is shown that the owest excitation levels correspond to Landau's honons. Using a higher approximation to the otential energy, the interaction between the phonons hould be obtained. Conditions for the validity of uthor's approach are discussed. R. EISENSCHITZ

536.48

573. Some comments on helium films. K. R. ATKINS. *Canad. J. Phys.*, **32,** 347–55 (*May*, 1954).

The Polanyi potential theory is applied to the elium film and leads to a qualitative understanding f the high density of the first few layers and the ifferential entropy. Between 1·75°K and the λ-point he film may consist of an inner solid portion, an ntermediate portion of helium I, and an outer portion f helium II. For thick films the variation of zero-oint energy with thickness must be considered. The zero-point energy of the Debye waves is shown o be important at film thicknesses of the order of 4×10^{-6} cm. The effect of heat radiation incident pon the film is considered. A.

536.48

574. First sound measurements in liquid helium. A. VAN ITTERBEEK AND G. FORREZ. *Physica*, **20,** 133–8 (*March*, 1954).

Measurements were carried out by means of an ultrasonic interferometer on the velocity of first sound n liquid helium between the boiling point and 1·1°K. The frequencies used were 220, 420, 512 and 800 kc/s. No dispersion was found for the velocity in He II. Values continued to increase below 1·2°K. A.

536.483

575. A Linde helium liquefier-cryostat combination suitable for operation down to 1·3°K. D. H. PARKINSON. *J. sci. Instrum.*, **31,** 178–80 (*May*, 1954).

The unit has a liquefaction rate of 800 cm^3/hr, combined with reasonable economy in the use of liquid hydrogen. It is suitable for experiments down to 1·3°K, either by mounting the apparatus in an inner vacuum chamber and cooling it by condensation or by direct immersion down a 9·8 mm bore tube to the main helium bath. A.

536.483 : 536.58

576. Thermoregulator for a liquid helium bath. W. S. BOYLE AND J. B. BROWN. *Rev. sci. Instrum.*, **25,** 359–60 (*April*, 1954).

A simple device is described for holding the temperature of any part of a liquid helium bath constant to within $\pm3\times10^{-5}$ deg K under normal conditions. A.

536.521 : 535.23

The effect of grooving the surface of a standard radiator. *See Abstr.* 6450

536.531 : 536.48

6577. Temperature measurement below 1°K. D. H. HOWLING, F. J. DARNELL AND E. MENDOSA. Letter in *Phys. Rev.*, **93,** 1416 (*March* 15, 1954).

Description of the absolute calibration of a carbon resistance thermometer without the need of magnetic measurements. This is done by demagnetizing a combination of the carbon resistor with a paramagnetic salt, the entropy-field relation of which is known for the starting temperature, and determining the heat required for changing the entropy of the demagnetized combination. H. LONDON

536.532 : 537.534

Application of thermocouples to target temperature measurement in the internal beam of a cyclotron. *See Abstr.* 6671

536.62

6578. Determination of heat capacity by pulse heating. T. E. POCHAPSKY. *Rev. sci. Instrum.*, **25,** 238–42 (*March*, 1954).

Describes an apparatus used to measure the heat capacity of metal wires by pulsed heating. The electrical energy supplied to the wire is determined with respect to a platinum standard while the temperature rise is determined from the change in resistance and the measured temperature coefficient of resistance. A maximum error of 5% in the specific heat might be expected with the apparatus as built, but the results agree with most published data to within a few per cent in the range 0°C to 650°C. A.

536.631

6579. Some apparent anomalies in low-temperature heat capacities. J. R. CLEMENT. Letter in *Phys. Rev.*, **93,** 1420 (*March* 15, 1954).

The anomalies of KCl [Keesom and Clark, *Physica*, **2,** 698 (1935)] and of Ag [Keesom and Kok, *Physica*, **1,** 770 (1934)] can be resolved if the measurements are re-evaluated on the "1949" temperature scale. The sudden rise in the Debye temperature observed with KCl at the lowest temperatures by Keesom and Pearlman [Abstr. 415 (1954)], who use the "1949" scale, can be substantially reduced if the measurements of the vapour pressure of helium by Kistemaker [Abstr. 103 (1947)] are used to improve the "1949" scale. H. LONDON

536.632

6580. The specific heat of liquid sulphur. H. BRAUNE AND O. MÖLLER. *Z. Naturforsch.*, **9a,** 210–17 (*March*, 1954) *In German.*

Reports results of measurements of the true specific heat between 120° and 440°C, using an adiabatic calorimeter. The specific heat curve exhibits a λ-point at 160°C. A "normal" specific heat curve is derived, obtained by subtracting the values arising from the transformation from the observed values and assuming a parabolic temperature variation for the "normal" curve. Enthalpy values are derived and compared with earlier values. Deductions are made as to the nature of the transformation. E. P. WOHLFARTH

536.656 : 537.312.62

Latent heat of transition of superconducting lead. *See Abstr.* 6630

THERMODYNAMICS 536.7/.8

536.7

6581. Variational and invariant properties deduced from the general expression for a balance. P. GLANSDORFF. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 11, 971–82 (1953) *In French.*

A general expression for the balance in continuous material media is deduced. The idea of a source of a function is developed and volume and mass sources defined. The character of the latter is underlined and extremals in an open or closed system are sought. A general theorem is thus obtained which includes and renders precise a provision of I. Prigogine according to which a minimum of entropy production, if it exists, in an open or closed system corresponds to a stationary state. F. E. HOARE

536.7

6582. Relativistic thermodynamics of irreversible processes. III. Systems without polarization and magnetization in an electromagnetic field. G. A. KLUITENBERG AND S. R. DE GROOT. *Physica*, **20**, 199–209 (*April*, 1954).

For Pt II, see Abstr. 2383 (1954). The phenomenological equations are given in four-dimensional and three-dimensional tensor form. It appears that, in comparison with theories which are not completely relativistic invariant, new terms occur in the forces (affinities). The relativistic Ohm's law is a special case of the general equations which are obtained for the diffusion phenomena. It appears that the electric current is a function not only of the electric and magnetic field vectors and of the gradients of the temperature and the partial specific Gibbs potentials of the chemical components, but is a function also of the local derivatives with respect to time of the two latter quantities and of the barycentric acceleration. A formulation for the theory with the help of relative flows of matter which are defined with respect to another reference velocity than the barycentric velocity is derived from the developed formalism. A.

536.7 : 539.132

Thermodynamic properties of *n*-dimethylaminodiborane. *See Abstr.* 6779

536.73

6583. Equivalence of the Clausius and Kelvin postulates. C. N. HAMTIL. Note in *Amer. J. Phys.*, **22**, 93–4 (*Feb.*, 1954).

Completes the symbolic demonstration of the above using Zemansky's results. F. E. HOARE

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

6584. An interpretation of the variable mass in Wessel's theory of the electron. S. J. CZYZAK. *Amer. J. Phys.*, **22**, 335–40 (*May*, 1954).

The work of Dirac, Bopp, Hönl, and Wessel on the theory of the electron is briefly reviewed. The equations of motion, with a variable rest mass, are integrated to obtain the velocities. The initial condition in this development can be so chosen that one obtains a motion which is analogous to the "Zitterbewegung" first derived by Schrödinger. Th connection between spin and radiation reaction for is clarified.

537.

6585. A new classical theory of electrons. II P. A. M. DIRAC. *Proc. Roy. Soc. A*, **223**, 438– (*May* 20, 1954).

For Pt II, see Abstr. 5092 (1952). The paper dea with several interpenetrating electric streams movi in accordance with the equations of Maxwell a Lorentz. An action principle is set up and then passage is made to the Hamiltonian form of t equations of motion. The Hamiltonian has co siderable analogy to that for point-charge electron but there is some discrepancy.

ELECTROSTATICS . DIELECTRICS 537.2

537.22

6586. On the triboelectric properties of vario fabrics of synthetic fibres. E. DARMOIS AND MARAIS. Letter in *J. Phys. Radium*, **15**, 189 (*Marc* 1954) *In French.*

The effect of humidity over the range 55–80% R.H is studied. Pure P.V.C. and certain fibre blends co taining it developed large charges but other fibres su as Dynel and Acrylan were uncharged abo 65% R.H. A. E. KA

537.2

6587. Contact charging between a borosilicate gla and nickel. J. W. PETERSON. *J. appl. Phys.*, **25**, 501- (*April*, 1954).

The charging of borosilicate glass spheres rolling c clean nickel has been studied under controlled co ditions of cleanliness, humidity and gas pressur Strong evidence indicates the process of char transfer to be a type of contact electrification ak to that operating between two metals. The observe charging is, however, influenced by other facto The amount of charge acquired increases with surfa areas in contact and hence with distance rolled un other factors intervene. The rate of charging depen on rolling speed and surface conductivity of t borosilicate glass, while the maximum equilibriu charge depends on the pressure of the ambient ga The gas pressure effect is shown to be caused b electrical discharge of the highly charged sections the borosilicate glass to the metal, as suggested b Gill, and this causes a minimum equilibrium charg to occur about 1 mm air pressure, as observed b Debeau. The effect of transverse electrical field reported by Gill and Alfrey is negligible for lo surface conductivity but becomes important at high surface conductivity, in particular above 40% relati humidity at 20°C.

537.223 : 621.319.3

6588. On the theory of the Van de Graaff electro static generator. A. W. SIMON. *Amer. J. Phys.*, 2 318–26 (*May*, 1954).

The detailed quantitative theory of a two-carrie constant potential, electrostatic generator is given. is shown that if the inductor of such a machine held at constant potential, the collector voltage als approaches a constant value, which is proportion

) the potential of the inductor, the factor of proportionality depending only on the geometry of the machine. It is shown that a Van de Graaff machine can be considered as a generator of the same type except that the two separate carriers are replaced by a single continuous belt. Some erroneous conclusions commonly made with respect to the action of the Van de Graaff machine are discussed. It is pointed out that a possible advance in the application of belt-type generators is operation in series to attain higher voltages. A.

537.226.2/.3

6589. The dielectric properties of some long-chain fatty acids and their methyl esters in the microwave region. T. J. BUCHANAN. *J. chem. Phys.*, **22**, 578–84 (*April*, 1954).

Measurements were made of the dielectric constant and loss of stearic, palmitic and some other acids in the solid and liquid states between wavelengths of 1 and 50 cm. The loss was small in the solid state, and there was no absorption peak in the wavelength range covered; in the liquid state the loss was greater with evidence of a small absorption peak near 3 cm. The methyl esters show an absorption peak in the microwave region in both the solid and liquid states. The measurements on the liquid methyl esters indicate that resonance absorption is occurring at a frequency of about 6000 Mc/s. Some ethyl esters were measured and were found to show a relaxation loss in the microwave region of the same order as the relaxation loss of the methyl esters but they showed no sign of resonance absorption loss. An attempt is made to explain both the relaxation loss and the resonance loss on the basis of a model which has already been used by Hoffman and Smyth. A.

537.226.2 : 548.736.4

6590. The properties of colloidal ferroelectrics. III. Barium titanate $BaTiO_3$. M. ANLIKER, H. R. BRUGGER AND W. KÄNZIG. *Helv. phys. Acta*, **27**, *No.* 2, 99–124 (1954) *In German.*

For Pt II, see Abstr. 1283 (1954). The properties of very small $BaTiO_3$ crystals have been investigated by means of X-ray diffraction, electron diffraction, electron microscopy and dielectric measurements. The ferroelectric properties change gradually with decreasing crystal size. The transition from the polarized (tetragonal) phase to the unpolarized (cubic) phase becomes smeared out over a temperature range which increases with decreasing particle size. The tetragonal spontaneous strain ($c/a - 1$), measured with X-ray diffraction, does not completely vanish, even at temperatures which are a few hundred deg. C above the Curie point of the macroscopic crystal (120°C). The value of ($c/a - 1$) at room temperature decreases with decreasing particle size. This suggests that domain configurations with closed flux are favoured (such configurations hinder the normal tetragonal spontaneous strain). Electron diffraction experiments indicate that the deviations from the normal ferroelectric behaviour are mainly due to a discrepancy between the interior of the crystal and a surface layer of about 100 Å thickness. The spontaneous tetragonal strain in this layer (measured with electron diffraction) seems to be larger than the volume average of the spontaneous strain (measured with X-ray diffraction), and is, moreover, independent of temperature. The surface appears to have a very high Curie temperature. The misfit between the surface layer and the interior causes the broadening of the transition region and lattice distortions, which manifest themselves in an anomalous broadening of the Debye–Scherrer rings. A.

537.226.31

6591. Reduction in the loss factor of certain ceramics by heat treatment. H. RAWSON. Letter in *Nature* [*London*] **173**, 447 (*March* 6, 1954).

The loss angle of steatite, fosterite and wollastonite ceramics is reduced by a factor of between 2 and 10 times, when these materials are heated at 1000°C for 60 hours. This may be due to a reduction in the number of lattice defect pairs, or to devitrification of the glassy phase in the ceramics. J. H. MASON

537.226.8

6592. The photo-dielectric effect. J. ROUX. *J. Phys. Radium*, **15**, 176–88 (*March*, 1954) *In French.*

Reviews work from 1909 to the present day on the changes in capacity and dielectric loss of a condenser whose dielectric is a crystalline phosphorescent powder, when it is illuminated with light of suitable wavelength to make the crystal phosphoresce.

C. A. HOGARTH

537.228.1 : 539.32

6593. Dynamic determination of elastic and piezoelectric constants. R. BECHMANN. *Telefunken Ztg*, **26**, 353–65 (*Dec.*, 1953) *In German.*

This is a review of the methods of determining the adiabatic elastic coefficients and moduli by measuring the natural frequencies of plates and rods excited in different ways. Factors which influence the accuracy of the measurements are briefly discussed. Reference is made to the temperature coefficients of the elastic and piezoelectric constants and to the measurement of the piezoelectric constants by observing the difference between the parallel and series resonance frequencies. H. J. H. STARKS

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311 : 536.413.2

6594. Some physical properties of metallic plutonium. W. B. H. LORD; J. G. BALL, J. A. L. ROBERTSON, P. MARDON, J. A. LEE, E. T. ADAMS. Letters in *Nature* [*London*], **173**, 534–5 (*March* 20, 1954).

Phase	α	β	γ	δ	ε
σ	150	116	115	111	123
$\frac{1}{\sigma}\frac{d\sigma}{dT}$	−20 to −40	−10	−4 to −20	+7	—
α	+50 to +65	+43	+39	−27	+20
ρ	19·25	17·3	16·7	15·7	16·3
Transition temperature °C					
Heating	136	225	320	480	
Cooling	85	160	240	480	

m.p. 640°C.

σ = Resistivity in μohm. cm; $(1/\sigma)(d\sigma/dT)$ = temperature coefficient of resistivity per deg C ($\times 10^{-5}$);

α = expansion coefficient per deg c ($\times 10^{-6}$); ρ = density in g/cm^3. The values given are in many cases very approximate. A. D. LE CLAIRE

537.311.3.08 : 621.317.73

6595. An instrument for measurement of very high resistance. F. J. LYNCH AND C. L. WESENBERG. *Rev. sci. Instrum.*, **25**, 251–4 (*March*, 1954).

An instrument for the accurate measurement of resistance in the range 10^9 to 10^{13} ohms is described. A constant current flows through the resistor under test, and the resulting potential drop is measured with an electrometer. The constant current is the displacement current flowing through a standard condenser when the potential difference across the condenser changes linearly with time. The potential drop across the resistor is measured by a recording dynamic-condenser electrometer. Provision is made for measuring resistance with potential drops from 3 mV to 10 V across the resistor. The accuracy of the resistance measurement is dependent only upon wire-wound potential dividers, the dimensions of a parallel plate condenser and the power-line frequency. The accuracy of the present instrument is about 0·5%. For this accuracy, the time of measurement is about $6R\times10^{-11} + 10$ sec. A.

537.311.31 : 538.221

6596. On the theory of electrical conductivity of ferromagnetic metals at low temperatures. A. I. REZANOV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 5, 935–7 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-206.*

The additional resistivity due to the interaction between the *s* and *d* electrons in a ferromagnetic [Abstr. 231 (1949)] is calculated and compared with the ordinary "phonon" resistivity. E. H. SONDHEIMER

537.311.32

6597. Electrical conductivity of $Cu_{1.8}S(Cu_9S_5)$. T. KAMIGAICHI. *J. Sci. Hiroshima Univ. A*, **16**, 325–30 (*Nov.*, 1952).

Measurements of the electrical conductivity of Cu_xS with x varying from 1·75 to 1·90. The electrical conductivity of $Cu_{1.8}S$ was about 2×10^4 ohm^{-1} cm^{-1} at room temperature and the temperature coefficient of conductivity was negative except between 40 and 100°c. Anomalous values of conductivity between 40–100°c are attributed to a phase transition Cu_2S or CuS to $Cu_{1.8}S$. A. E. DE BARR

537.311.32 : 536.631

6598. Electrical conductivity and anomalous heat capacity of nickel sulphide. K. SHIMOMURA. *J. Sci. Hiroshima Univ. A*, **16**, 319–23 (*Nov.*, 1952).

Anomalies in the curves of specific resistance and of thermal capacity versus temperature (0–600°c) at 410°c (heating), 330°c (cooling), 165°c (heating) are attributed to phase transitions between hexagonal and rhombohedral forms of NiS. A. E. DE BARR

537.311.32 : 537.32

6599. On the electrical properties of the polycrystalline boron. I. R. UNO, T. IRIE, S. YOSHIDA AND K. SHINOHARA. *J. Sci. Res. Inst.* [*Tokyo*] **47**, 216–22 (*Dec.*, 1953).

Two kinds of polycrystalline boron were prepared, and their electrical conductivity and related properties were measured. The first kind was prepared by thermal decomposition of BBr_3 in vacuum, and the second by reducing it in a hydrogen atmosphere at about 1500°c. The conductivity of the former is of the order of $10^{-3}\,\Omega^{-1}\,cm^{-1}$ at about 200°c and increases very rapidly with temperature, while that of the latter is rather high, of the order of $10\,\Omega^{-1}\,cm^{-1}$ at room temperature, and increases slowly with temperature. The high-frequency effective resistance of the former decreases at higher frequencies and that of the latter does not show much change with frequency. It is considered that such differences may be largely due to the existence of grain boundaries or inhomogeneities rather than difference of impurities. A.

537.311.32 : 537.31

6600. On the electrical properties of the polycrystalline boron. II. T. IRIE, R. UNO, S. YOSHIDA AND K. SHINOHARA. *J. Sci. Res. Inst.* [*Tokyo*] **47**, 223– (*Dec.*, 1953).

The temperature dependency of the thermoelectric power has been investigated over the temperature range from 100 to 800°K on polycrystalline boron samples. The thermoelectric power of the sample prepared in hydrogen atmosphere increases proportionally with the logarithm of absolute temperature in the measured temperature region, and that prepared in vacuum shows similar behaviour at least up to 600°c above room temperature. Such behaviour is expected when the sample is an impurity semiconductor having so small activation energy that all the impurity centres are ionized and yet intrinsic conduction does not appear. A.

537.311.32 : 548.7

6601. Electron conduction in coloured alkali halide crystals. J. BOROS AND Z. SIBALSZKY. *Acta phys. Hungar.*, **2**, *No.* 4, 277–88 (1952) *In German.*

The electrical conductivity of NaCl, KBr and KCl is investigated as a function of temperature and semi-conduction activation energies determined and compared with those of other workers and with values from *F*-centre absorption measurements. The electrical and optical values show close agreement. G. F. J. GARLICK

537.311.33

6602. Some remarks on Gisolf's theory of the electron fluctuations of semiconductors. K. W. BÖER. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 87–96 (1954) *In German.*

The current fluctuations due to fluctuations in the concentration of carriers is investigated for an infinite and for a finite crystal taking account of statistically distributed lifetimes of the conduction electrons. The effect of the field distortion in the boundary layer near an electrode is also discussed. The magnitude of these effects is evaluated for a typical semiconductor and compared with the thermal noise. F. ANSBACHER

537.311.33 : 538.63

6603. The transverse galvanomagnetic effects in semiconductors. J. APPEL. Note in *Z. Naturforsch.*, **9a**, 167–74 (*Feb.*, 1954) *In German.*

Work of Whitesell and Johnson [Abstr. 3303 (1953)] is developed and equations are found for the magnetoresistance and Hall effect for the limiting cases of very strong or very weak magnetic fields. Two mechanisms for free carrier scattering are assumed. C. A. HOGARTH

537.311.33 : 538.63

04. The magneto-resistance effect in a cubic niconductor with the spheroidal energy surfaces. . SHIBUYA. Note in *J. Phys. Soc. Japan*, **9**, 134–5 *n.–Feb.*, 1954).

The collision frequency of electrons with lattice brations is, under the conditions assumed, approxiately proportional to the square root of their ergy. Magnetoresistance constants are tabulated, r three special cases of the position of the bottom the conduction band. A. E. DE BARR

537.311.33 : 538.221

505. Oxide systems possessing interesting electical and magnetic properties. E. J. W. VERWEY. *ngew. Chem.*, **66**, *No.* 7, 189–92 (1954) *In German.*

Discusses multi-component systems containing most invariably oxides of Fe and also of elements f the first transition series of the periodic system. hese systems are sintered materials with a NaCl, ematite, or spinel structure, and are known as the black" ceramic materials of double technical nterest: (1) as semiconductors they present possiilities in the field of special resistors, and (2) it is ossible to utilize their magnetic properties due to the rrangement of cations. 15 refs. F. LACHMAN

537.311.33

606. On the variation of high-temperature conuctivity of cuprous sulphide with sulphur vapour ressure. T. KUSHIDA. *J. Sci. Hiroshima Univ. A*, **6**, 75–80 (*July*, 1952).

The variation was measured at 550°C. At lower apour pressures conductivity σ increases slightly with increasing vapour pressure in agreement with he relation $\log \sigma = \text{const.} + \frac{1}{4v} \log P_s$ $v \doteqdot 6$. An brupt increase of σ of about 300 times is seen at apour pressure 0·22 mm Hg. This is found to correspond to the transition from Cu_2S to $Cu_{1.8}S$. A.

537.311.33

6607. The effect of heat treatment on the electrical properties of germanium. R. J. HODGKINSON. *G.E.C. J.*, **21**, 63–70 (*Jan.*, 1954).

The mechanism of conduction by "acceptors" and "donors" is explained and the possible effects of impurities discussed. In the experiment described the specimen, a *p*-type crystal, was subjected to repeated periods of heat treatment up to 22 hr at 550°C. The conductivity at first decreased; then, as the crystal changed from *p* to *n*-type, it increased again to an approx. constant value. A further succession of periods up to 30 hr at 450°C saw a further increase of conductivity. The results obtained generally agree with those of other workers but uncertainty exists as regards behaviour at temperatures above 900°C. It is suggested that thermal acceptors arise from the presence of Cu atoms, whose solubility varies with temperature. H. G. M. SPRATT

537.311.33 : 548.7

6608. Directional properties of the cyclotron resonance in germanium. B. LAX, H. J. ZEIGLER, R. N. DEXTER AND E. S. ROSENBLUM. Letter in *Phys. Rev.*, **93**, 1418 (*March* 15, 1954).

Observation of cyclotron resonance [see Abstr. 2432 (1954)] at 8895 Mc/s in relatively pure *n*- and *p*-type Ge at liquid helium temperatures. The samples studied were rods cut parallel to [110] and by rotating the sample the applied transverse field could be lined up with any direction in the (110) plane. The data for *n*-type Ge are well described by a conduction band structure in which the Brillouin energy surfaces consist of eight ellipsoids of revolution lying along [111] axes. No directional effects were observed with *p*-type samples. A. E. DE BARR

537.311.33

6609. Resistivity striations in germanium crystals. P. R. CAMP. *J. appl. Phys.*, **25**, 459–63 (*April*, 1954).

Germanium metal, both single crystalline and polycrystalline, is frequently found to contain sharp fluctuations in impurity concentration. These are superimposed on the gradual variations expected as the result of ordinary segregation processes. A simple technique for detecting fluctuations of this kind has been developed. It consists in electroplating on to the Ge a thin Cu film. H.V. pulses are applied to the sample, the resulting current causing the Cu to plate preferentially on to the low-resistivity portions of the Ge. The striations are thereby rendered visible. The method is more sensitive than resistivity scanning and does not involve the use of radioactive tracers. This technique has been applied to a number of samples. The origin, value, and elimination of these fluctuations are discussed briefly. A.

537.311.33

6610. Antimony content and semiconduction properties of synthetic lead sulphide photoconductive layers. H.-G. SMOLCZYK. *Naturwissenschaften*, **41**, *No.* 4, 84 (1954) *In German.*

Experimental results suggest a method for the production of *p–n* junctions. C. A. HOGARTH

537.311.33 : 538.632

6611. On the electrical properties of silicon single crystals. I. Y. KANAI. Note in *J. Phys. Soc. Japan*, **9**, 132–3 (*Jan.–Feb.*, 1954).

Conductivity, Hall coefficient and mobility as functions of temperature are plotted for two Si *n*-type single crystals, in the range −150 to 500°C and compared with results of Pearson and Bardeen (1949) for polycrystalline specimens of similar carrier concentration (a few times 10^{17} cm^{-3}). For the single crystals the electron mobilities are higher, particularly at lower temperatures. C. A. HOGARTH

537.311.33 : 538.632

6612. Electrical properties of pure tellurium and tellurium–selenium alloys. A. NUSSBAUM. *Phys. Rev.*, **94**, 337–42 (*April* 15, 1954).

The resistivity and Hall coefficient of pure, single-crystals tellurium and of six single-crystal tellurium-selenium alloys, ranging from 2·7% to 13·2% selenium by weight, were measured over the temperature range 90°K to 550°K, and a few of the samples were taken down to liquid helium temperatures. It was found that the alloys show the same double reversal in the Hall coefficient that is exhibited by pure tellurium, going from *p*-type to *n*-type in the general region of room temperature, and reversing back to *p*-type at temperatures near 200°C. The upper reversal temperature decreases and the forbidden

bandwidth, as obtained from the slope of the resistivity *v.* temperature curves, increases with increasing selenium concentration. The room temperature resistivity and lower reversal temperature do not vary monotonically with alloy concentration but a correlation among them has been found based on ideal semiconductor theory. An explanation of the anomalous Hall coefficient which considers the effect of the electron configuration and the lattice structure on the energy-band picture is discussed and it is shown how this hypothesis fits the observed facts. As a further test of this theory, the effect of a hydrostatic pressure of 5000 lb/in.^{2} on the two Hall reversal temperatures was measured. A.

537.311.33 : 621.315.59 : 621.314.63

6613. Diode theory in the light of hole injection. J. A. SWANSON. *J. appl. Phys.*, **25**, 314–23 (*March*, 1954).

Classical diode theory, as applied to metal point contacts made to an *n*-type semiconductor, is adequate only for small forward voltages at which, under certain conditions, hole current may be negligible. The shape of the theoretically predicted diode characteristic is not affected by the hole injection process at low voltages, no matter what the composition of the current. However, for voltages in excess of a certain value, dependent only on the resistivity of the material ($\sim 0{\cdot}1$ V for 5 Ω-cm Ge), the spreading resistance is comparable to the barrier resistance, and it is the hole injection process which accounts for continued rectification. The extent to which the spreading resistance is decreased by hole injection depends on the ratio, γ, of hole current to total current. A theory is given of the effect of this ratio on the diode characteristic at higher forward voltages. A method of measuring γ from *V–I* characteristics alone is indicated. A.

537.311.33 : 537.312.5

6614. The "photo-aftereffect" of germanium crystal rectifiers. M. KIKUCHI AND T. ONISHI. Note in *J. Phys. Soc. Japan*, **9**, 130–1 (*Jan.–Feb.*, 1954).

Experimental results on current creep in germanium contact rectifiers during and after illumination are described. A tentative explanation in terms of surface traps of long time constant is offered.

C. A. HOGARTH

537.311.33 : 621.314.63

6615. Germanium diodes from spherical pellets. W. C. DUNLAP, JR. *J. appl. Phys.*, **25**, 448–51 (*April*, 1954).

A method for constructing high-voltage diodes, utilizing 15-mil germanium spheres instead of the usual flat wafer. The spheres are produced within a few minutes in quantities of several hundred thousand or more by blowing molten high-purity germanium from a graphite crucible. The spherical pellets can be annealed, ground, etched, and assembled into diodes by techniques easily adaptable to automatic mass production. The assembled diode uses a sphere-plane contact rather than the conventional whisker contact. Peak back-voltages in the range 50–100 V are easily obtainable. Series-assembled units for higher voltages are easily made. A.

537.311.

6616. On the a.c. characteristics of silicon *p* junction alloy diodes. Y. KANAI. Note in *J. Phy Soc. Japan*, **9**, 143–4 (*Jan.–Feb.*, 1954).

Al alloyed diodes were examined. Forwa characteristics agreed with the theoretical form b reverse showed no saturation. Low voltage adm tances were measured at room temperature fro 300 c/s to 150 kc/s. The results agreed well wi Shockley's theoretical curves. Values of hole lifetim in the *n*-region were calculated as 27 μsec for specimen with uniform *n*-region and as 300 μsec for specimen with a retarding field in the *n*-region.

C. A. HOGART

537.311.6 : 621.315.5 : 621.3.011.2

6617. The impedance presented by hollow or sol cylindrical conductors to impulse currents. I ZANOBETTI. *R.C. Accad. Naz. Lincei*, **15**, 200– (*Sept.–Oct.*, 1953) *In Italian.*

During a transient, the ratio of the instantaneo values of the e.m.f. and the current is larger than the steady state. This impedance must be known ve accurately in the case of conductors used for t measurement of impulse currents. An expression given for its calculation, based on the formalis previously developed by the author [Abstr. 24 (1954)]. L. PINCHERL

537.311.62 : 621.316.8 : 621.3.011.2

6618. High-frequency resistance of thin film R. BROUDY AND H. LEVINSTEIN. *Phys. Rev.*, 9 285–9 (*April* 15, 1954).

Measurements of h.f. resistance of thin films ha been performed. It is shown that the relatively sma decrease of resistance with frequency occurring fo uniform resistance is due to self-capacitance; th simple transmission line theory of this effect, original presented by Howe, is incorrect. Additional decrea of h.f. resistance beyond that due to self-capacitanc has been found to be due to the presence of non uniform regions in the resistor and not to the presen of intercrystallite barriers in the frequency rang considered. Properly interpreted, h.f. measuremen can give information on the presence of gro inhomogeneities in films. A

537.311.62 : 621.383 : 621.3.011.2

6619. High-frequency resistance of photoconductiv films. R. BROUDY AND H. LEVINSTEIN. *Phys. Rev* **94**, 290–2 (*April* 15, 1954).

Measurements of h.f. resistance and photocon ductivity have been performed on PbTe infrare photocells, and interpreted in the light of a recen analysis of h.f. resistance of thin films (precedin abstract). H.F. data show the presence of macro scopic non-uniformity in the photoconducting layer which decreases upon illumination. Since thi technique will not detect the presence of inter crystallite barriers, their action in photoconductivit can neither be proved nor disproved by this metho A

537.312.

6620. Photoconduction of alkalihalide crystals whic adsorb dyes. H. YAGI. *Mem. Coll. Sci. Univ Kyoto A*, **26**, 75–84 (*Oct.*, 1950).

Dicyanine, kryptocyanine and phenosafranine dye

sorbed on rock salt crystals show characteristic sorption bands and illumination in these bands cites volume photoconductivity in the crystal. otoelectric measurements are also made on the es coated on a silver plate. It is suggested that the west excited states of the dye molecules lie in the nduction levels of NaCl and so hand over electrons the bulk crystal to cause photoconduction.

G. F. J. GARLICK

537.312.5

6621. Measurements of the external photoelectric effect of polycrystalline layers of alkaline halides by means of a G–M counter. B. SUJAK. *Acta phys. polon.*, **12**, *No.* 3–4, 241–3 (1953).

Layers of NaCl or KCl, 10^{-1} mm thick, are formed on the inner surface of the anode of a cylindrical G.M. counter. When sensitized by discharge a photoelectric emission is observed which shows fatigue. The emission is a maximum at 480 mμ for NaCl and at 570 mμ for KCl. Photocurrents measured by this technique were 10^2–10^3 electrons/sec (10^{-17}–10^{-16} amp.). G. F. J. GARLICK

537.312.5

6622. On the photocurrent of high purity SiC single crystal. K. SATO AND M. NAMBA. *J. Phys. Soc. Japan*, **9**, 139 (*Jan.–Feb.*, 1954).

p-Type crystals of SiC ($\rho \sim 10^4$ Ωcm) show photoconductivity when biased in forward direction and illuminated in the infrared region. G. F. J. GARLICK

537.312.5

6623. Pure electrical excitation of glow curves. K. W. BÖER AND U. KÜMMEL. Note in *Z. Naturforsch.*, **9a**, 177–8 (*Feb.*, 1954) *In German.*

By applying a continuously increasing electric field to a previously excited CdS crystal electrical conduction *v.* field curves are obtained which show a banded structure. The unexcited crystal gives a much lower structureless conductivity for the same fields. It is assumed that the increasing field strength causes ejection of electrons from successively deeper trapping states. G. F. J. GARLICK

537.312.5

6624. Further evidence for the energy gap of lead sulfide. G. R. MITCHELL AND A. G. GOLDBERG. Letter in *Phys. Rev.*, **93**, 1421 (*March* 15, 1954).

The long wavelength cut-off at room temperature of the photovoltaic effect obtained with a PbS crystal containing a *p–n* junction, coincides with that of the photoelectromagnetic effect in galena [Abstr. 1326 (1954)], confirming an energy gap of 0·4 eV.

J. FRANKS

537.312.5

6625. Photoconductivity in gold-germanium alloys. R. NEWMAN. *Phys. Rev.*, **94**, 278–85 (*April* 15, 1954).

Photoconductivity has been observed at 77°K and 22°K in *n*- and *p*-type gold-doped germanium. The low-energy thresholds for impurity photoconduction are compatible with the activation energies found by conventional electrical measurements. Quenching effects were found in some *n*-type samples. Prominent quench bands were found at 0·8 and 0·66 eV. The characteristics of the quenching were observed as a function of light intensity, applied voltage and temperature. An interpretation of the quenching data in terms of a hole trap model is suggested. A.

537.312.6 : 539.23

6626. The temperature coefficient of resistance of thin silver films. S. TUNAKAN. *Rev. Fac. Sci. Univ. Istanbul A*, **17**, 394–402 (*Oct.*, 1952) *In German.*

Experiments on thin silver films (10 to 200 mμ) evaporated on to glass show that the temperature coefficient of resistance in the range 0 to 70°C increases with film thickness until it reaches the value for the bulk metal at about 200 mμ. The variation of resistivity with temperature, i.e. $\partial\rho/\partial T$, is independent of film thickness and is equal to that of the bulk metal. The dependence of the temperature coefficient of resistance on film thickness is thus due only to the additional resistance of the film. M. R. HOPKINS

537.312.62

6627. On the theory of superconductivity: the one-dimensional case. H. FRÖHLICH. *Proc. Roy. Soc. A*, **223**, 296–305 (*May* 6, 1954).

The one-dimensional case of free electrons interacting with lattice displacements is solved by a self-consistent method. It is found that for a certain range of the interaction parameter a single sinusoidal lattice displacement is strongly excited in the lowest level of the system. Its wavelength is such as to create an energy gap in the single-electron energy spectrum with all states below it filled, and all above it empty. This periodic lattice displacement plays the rôle of an "inner field" and leads to periodic fluctuation in the electronic density in such a way that the two stabilize each other. In an infinite medium described by a periodic boundary condition they are not fixed absolutely in space, but only relative to each other. Excitation of electrons across the gap leads to a decrease in both the electronic density fluctuations and the width of the gap. The whole system, electrons plus lattice displacements, can move through the lattice without being disturbed provided the velocity v is sufficiently small. The inertia of this system is equal to that of all electrons augmented by a term due to the lattice displacements. Elastic scattering of individual electrons which normally leads to the residual resistance is impossible if v is sufficiently small. The linear specific heat of normal electrons is eliminated and replaced by an exponential term. A.

537.312.62

6628. Speculations on the behavior of positrons in superconductors. M. DRESDEN. Letter in *Phys. Rev.*, **93**, 1413 (*March* 15, 1954).

According to current ideas positron annihilation is preceded by the formation of positronium, the triplet state of which has a longer life than the singlet. Those positrons that land in the triplet state commonly convert into the singlet before they annihilate. The author assumes that this conversion is retarded when a metal becomes superconductive. Unpublished experiments by Stump and Talley and by Millet are mentioned in which positrons annihilating in lead at liquid helium temperatures show a complex lifetime scheme with a longer-lived component which is absent at liquid nitrogen temperatures.

H. LONDON

537.312.62

6629. Superconducting compounds. B. T. MATTHIAS, E. CORENZWIT AND C. E. MILLER. Letter in *Phys. Rev.*, **93**, 1415 (*March* 15, 1954).

Confirming the first author's criteria for superconductivity [Abstr. 2444 (1954)] the following compounds have been found to become superconducting. MO_3P near 7°K, Rh_5P_4 at 1·22°K, $(Ni_{0.12}Pd_{0.88})As$ to $(Ni_{0.75}Pd_{0.25})As$ above 1·06 with $(Ni_{0.25}Pd_{0.75})As$ at 1·6°K (maximum), Rh_9S_8 at 5·8°K, 2Rh: 3·4Se to 2Rh: 4Se above 1·04°K, 2Rh: 4Te at 1·51°K (maximum). H. LONDON

537.312.62 : 536.656

6630. Latent heat of transition of superconducting lead. R. L. DOLECEK. *Phys. Rev.*, **94**, 540–3 (*May* 1, 1954).

Utilizing magnetic heating, calorimetric measurements of the latent heat of transition of superconducting lead were made in the temperature range 2·5°K to 7·0°K. The values obtained demonstrate the inadequacy of the assumption of a parabolic or cubic critical magnetic field for lead, but are consistent with the assumption of a quartic critical field approximation. The latent heat data obtained are used to derive expressions for the normal and superconducting electronic specific heat. A.

537.312.8 : 537.311.62

6631. The magneto-resistance effect in metals at high frequencies. B. DONOVAN. *Proc. Phys. Soc.* [*London*] *A*, **67**, 305–14 (*April*, 1954).

An examination is made of the effect of a magnetic field on the surface impedance of a metal in which there are two overlapping bands of normal form. In general it is not possible to express the surface resistance, as a function of frequency and field strength, in convenient analytical form, but the results are depicted graphically for a number of special cases. At low frequencies the relative change in the surface resistance due to the field is independent of frequency and its variation with field strength is very similar to that obtained in d.c. experiments. At high frequencies it is shown that in all cases the magnetoresistance effect ultimately drops to zero. The frequency region in which this phenomenon occurs is determined by the relaxation time and lies in the far infrared for normal metals. From a comparison with the available experimental results for bismuth it is inferred that the relaxation time in bismuth is abnormally large. A.

537.32

6632. Thermoelectric e.m.f. of W — Hg at high temperatures. S. KOC. Letter in *Czech. J. Phys.*, **3**, *No.* 2, 165 (1953) *In Russian.*

The thermoelectric e.m.f. in millivolts is given as $2{\cdot}006\times10^{-4}T^{1{\cdot}723}$ where T is the temperature in °C within the range 100–1500°C. J. M. HOUGH

537.32

6633. A method for the precise measurement of thermal e.m.f. of samples with great thermal conductivity. J. TAUC, J. BEDNÁŘ AND A. ABRAHÁM. Letter in *Czech. J. Phys.*, **3**, *No.* 4, 314–15 (1953) *In Russian.*

Describes an apparatus in which the two ends of a specimen of the material under investigation (semiconductors are suggested) can be kept at precise an known temperatures. No experimental results. J. M. HOUG

537.32 : 539.4.016

6634. Thermoelectric power of cold-worked copp at low temperature. M. J. DRUYVESTEYN AND K. BLOK VAN LAER. Letter in *Nature* [*London*] **173**, 59 (*March* 27, 1954).

For a given amount of cold working the relativ increase in thermoelectric power is greater than th relative increase of resistivity. Results of experimen down to 83°K are described. C. A. HOGART

537.323 : 537.311.3

6635. The effect of thermal emission of holes on th thermal e.m.f. of *n*-type semiconductors. J. TAU AND Z. TROUSIL. *Czech. J. Phys.*, **3**, *No.* 2, 120– (1953) *In Russian.*

On measuring the thermal e.m.f. of *n*-type sem conductors, it was observed that the character of th dependence on the temperature was different whe using a cold point and a heated flat electrode fro that when using two flat electrodes. This effect ca be explained theoretically by the following con ception. Under the point electrode a large tempera ture gradient is created which, due to the diffusion o holes from the warmer parts, causes a greater con centration of the current carriers in the cooler part than corresponds to the equilibrium value. Th potential barrier under the point prevents the electron from entering the contact but does not prevent the penetration of the holes. The excess of holes cause an electric voltage analogous to that in a barrier laye cell. On the assumption that most of the temperatur gradient occurs at a distance which is small compared to the diffusion distance of the holes, that the tempera ture gradient between the surface of contact of the tungsten point and the sphere of radius r_0 is negligible and that the concentration of the holes compared to the concentration of *n*-type impurities is small, an expression was derived for the additional voltage ΔU caused by the excess of holes. Within the limits o validity of the derived theory, i.e. for lower tempera tures, quantitative agreement was obtained with experiment. For higher temperatures the measured curve always lies below the theoretical. A possible explanation is that the potential barrier loses its efficiency at higher temperatures, a fact supported by measurements made at high temperatures. A.

537.323 : 537.311.33

6636. The theory of the thermal e.m.f. of semiconductors. J. TAUC. *Czech. J. Phys.*, **3**, *No.* 4, 282–303 (1953).

After a discussion of the present theory of the thermal e.m.f. of semiconductors, the theory is extended to non-homogeneous semiconductors. Its relationship to thermodynamics is discussed and it is then applied to the study of the influence of potential barriers. Further cases are discussed in which the velocity or the concentration of electrons does not conform to a state of thermal equilibrium as in the case of diode-type barriers or for injected current carriers. The results are applied to a discussion of the influence of high temperature gradients. The influence of minority current carriers on thermal e.m.f. is

tematically treated. Equations are derived and magnitudes of certain anomalous effects are mated. Some of these have not yet been experintally observed. A.

ELECTRIC DISCHARGES 537.52

537.523.3

37. Fast time analysis of intermittent point-to-ne corona in air. II. The positive pre-onset eamer corona. M. R. AMIN. *J. appl. Phys.*, **25**, 8–63 (*March*, 1954).

Analysis has been made of pre-onset streamers in om air at 760 mm with a fast oscilloscope using both notomultiplier and electrical registration. The ape of the photon pulse observed by W. N. English confirmed, and is interpreted. Current and minosity roughly parallel each other in the streamer. p velocities ranged from 6×10^7 cm/sec to $\times10^7$ cm/sec, being highest near the point. The minosity is constant over the path except at the ry beginning and at the end of the path suggesting at ionization is also constant. The net number of positive ions left behind per cm length of streamer consequence of the electron flow into the point constant, and has been measured to be about $\times10^9$ ions per cm in general agreement with earlier ork. Lateral deflection of the ends of streamer acks by space charge left behind from previous reamers was directly observed. A.

537.523.3

638. Direct-current corona. R. F. SAXE. Letter *Nature* [*London*] **173**, 592–3 (*March* 27, 1954).

Measurements of the light emission from atmospheric-pressure air corona were made with a photoultiplier tube and a wide-band amplifier (bandwidth ~ 100 Mc/s). Positive point-plane geometry vas used. The observed light pulses are described; ropagation velocities were also measured.

J. D. CRAGGS

537.523.4

6639. Effect of physical properties of the electrode material on the migration of matter in short concentrated discharges in a dielectric medium. B. H. ZÍTKA. Letter in *Czech. J. Phys.*, **3**, *No.* 1, 94–6 (1953) *In Russian.*

The main part of the apparatus is a spark discharge gap with rotating disk-shaped electrodes. The form of the working impulse was checked by a double-ray oscillograph. When working with Pb, Sn, Zn, Cu, Al, Ni and Fe electrodes it has been found that the current (and possibly also voltage) curve of the discharge does not depend on the electrode material. With electrodes made of the same material, the anode and cathode matter losses vary approximately inversely as the heat of fusion of the material. When the anode material is the same for different cathodes, the anode losses decrease as the cathode material becomes harder. F. LACHMAN

537.523.4

6640. The erosive effects of transient arcs in an electrolytic medium. V. HERMOCH. *Czech. J. Phys.*, **3**, *No.* 3, 232–9 (1953) *In Russian. Summary* (1 *p.*) *in English.*

An experimental study of the erosion rates in sparks with different current pulse shapes (condensed discharges and rectangular pulse discharges). Various metals are used for electrodes, and the sparks are immersed in electrolytes. There is some discussion of electrode erosion mechanisms, and electrolytic surface layer effects. J. D. CRAGGS

537.523.4

6641. Erosive effects of condensed arcs in a dielectric medium. B. H. ZÍTKA. *Czech. J. Phys.*, **3**, *No.* 3, 241–54 (1953) *In Russian. Summary* (1 *p.*) *in English.*

Presents experimental data relating to electrode erosion rates, for a wide range of metals, in spark discharges (transient arcs). The current pulse was obtained from a 500 V 500 μF condenser with a peak current of about 2500 A and a pulse duration of about 150 μsec. Erosion mechanisms are discussed.

J. D. CRAGGS

537.523.4

6642. Some aspects of breakdown streamers. L. B. LOEB. *Phys. Rev.*, **94**, 227–32 (*April* 15, 1954).

Photomultiplier and oscillographic study of positive breakdown streamers yields values of current and distance of tip advance as a function of time. From these the relatively constant number n of excess positive ions left behind by the streamer per cm advance and the tip velocity v_t are obtained. These are related to the linear electron density n_c per cm of streamer channel plasma and the electron drift velocity v_c in the channel by $n_c v_c = n v_t$, with $v_t > v_c$. Since v_c is related to the gradient X_c in the channel by well-known drift velocity data, it is possible to limit the range of values of n_c and v_c. The limiting conditions are that $n_c > n$, $\int_0^x X_c dx < V_x$, where V_x is the applied potential, and finally that X_c must be sufficiently large to maintain the channel conducting despite dissociative recombination and dissociative attachment losses. In longer channels heating cannot be neglected. The dense positive space charge left behind by the electron current in the ionized channel of radius R causes a radial expansion of the excess space charge to a radius R' by incoming electron avalanches leading to a broad transient luminosity for some distance behind the tip. The tip and the conducting channel taking the return stroke, however, retain their small radius R. A.

537.523.5

6643. Discharge in the Leidenfrost-layer of mercury vapour. S. KOC. *Czech. J. Phys.*, **3**, *No.* 4, 304–8 (1953) *In Russian.*

Describes a discharge observed in the Leidenfrost layer of mercury vapour, produced between a submerged red-hot metal anode and a liquid mercury cathode. The discharge burns independently even if the voltage of the source is about 2 V. It was found that with the creation of the Leidenfrost layer the mercury surface started to oscillate mechanically, causing a periodic make and break of the contact. Since the voltage is very low no arc can be produced directly, the interruption of the current, however, is

steep enough as to make the self-induced voltage in the circuit reach values sufficient to support a temporary arc. It was found that this arc had a cathode spot and that its minimum voltage was about 7·5 V. A.

537.525.3 : 537.525.72 : 537.525.8

6644. Influence of "ageing" on non-self-maintained region of a low frequency a.c. discharge in iodine vapour. N. SUBRAHMANYAM AND N. A. RAMAIAH. *J. sci. industr. Res*, **12 B**, 641–2 (*Dec.*, 1953).

Discusses various effects associated with breakdown (current-voltage) characteristics in electrodeless a.c. corona in iodine vapour. J. D. CRAGGS

537.525.3 : 537.525.72 : 537.525.8

6645. Studies of light absorption under conditions productive of Joshi effect in mercury vapour under ozoniser discharge. V. VENKATESWARLU AND N. A. RAMAIAH. *J. Phys. Soc. Japan*, **9**, 225–32 (*March–April*, 1954).

Data for the production of Δi (Joshi effect) corresponding to 100% photo-reduction of the conductivity in mercury vapour excited by potentials near "threshold potential" V_m, are presented. Light absorption of mercury vapour was studied against hydrogen discharge when a fine absorption line occurred at 2536 Å whose intensity remained sensibly the same for the excited vapour; that excited near V_m and also when irradiated to give appreciable Δi. Results using the tungsten lamp and mercury arc also showed no noticeable difference between normal and excited vapour under conditions causing large Δi. It is considered that the Joshi effect is not a consequence of selective light absorption by the gaseous phase. A.

537.525.5 : 535.338

6646. Spectrum intensities and radio-frequency noise in a d.c. hydrogen arc. S. E. WILLIAMS AND V. MASLEN. Letter in *Nature* [*London*] **173**, 361–2 (*Feb.* 20, 1954).

Reports measurements on the effect of a shunt capacitance on the intensity of emission, in the region of Lyman α, (1215 Å) from a d.c. hydrogen arc ($\sim$ 1 mm Hg pressure, 5 A/cm^2 current density). The r.f. noise also varied with shunt capacitance; the frequencies studied lay between 338 kc/s and 17 Mc/s. J. D. CRAGGS

537.525.6 : 538.561

6647. The dispersion relation of plasma oscillations in an external electric field. M. HASIKUNI. *J. Sci. Hiroshima Univ. A*, **17**, 129–38 (*Aug.*, 1953).

The properties of an unbounded plasma in an external electric field are discussed. In this case, the Boltzmann equations are separated into two parts: The one is independent of such disturbances as plasma oscillations, and the other is not. The former is the "common" equation, which is used to discuss the properties of ionized gases in which the disturbances are not present. The conditions obtained from it are initial conditions of plasma oscillations. The latter is a characteristic equation of plasma oscillations. As a conclusion, it is shown that when a certain mode of oscillation with some frequency satisfying the dispersion relation is excited, its harmonic overtones necessarily follow. The dispersion relation is given with an integral equation. Lastly it is shown briefly that some of the dispersion relations obtained by other investigators are included in present equation as special cases.

537.52

6648. Electron energy distribution in the stria hydrogen discharge. R. L. F. BOYD AND N. TWIDDY. Letter in *Nature* [*London*] **173**, 633 (*Apri* 1954).

Describes preliminary measurements, made w probes, of electron energy distributions in the positive column in hydrogen (about 0·055 mm pressure) hot cathode discharges. Energy distri tions and Langmuir characteristics are displa directly on a c.r.o. Typical records are given. J. D. CRA

537.52

6649. The determination of the temperature of cylindrical column of a xenon high pressure dischar H. SCHIRMER. *Z. angew. Phys.*, **6**, *No.* 1, 3–9 (1954) *German.*

Gives first a general discussion of the conducti of a plasma (a highly ionized, sensibly space-cha free, discharge channel). In the treatment the dr current equation is developed using the Saha therm ionization equation and correcting for the effect of positive ions on the electron mobility. Tempe tures ($\sim$ 7000°K) are then quoted for a 35 A h pressure xenon discharge, dissipating abo 940 W/cm^3. J. D. CRA

X-RAYS 537.531

537.531 : 535.33

6650. An X-ray tube for spectroscopy, in which electrons are focused by means of a solenoid on to rotating anticathode and are guided on to it by mea of a suitable deflecting field. H. KIRCHER. *Optik*, *No.* 4, 196–8 (1954) *In German.*

537.531 : 535.33

6651. Total-absorption X-ray spectrometry: applic tion to betatron experiments. H. W. KOCH A R. S. FOOTE. *Nucleonics*, **12**, 51–3 (*March*, 1954).

A scintillation spectrometer employing two N crystals 4 in. long by 5 in. diameter, set end to end, described. X-ray photons in the energy range 0 to 50 MeV entering the crystals in a beam along t axis, can be detected with $>$ 80% efficiency a $>$ 11% resolution in energy. The scintillators a canned in brass and Al containers lined with Mg powder and are viewed with 4 photomultipliers each crystal. The outputs of the 8 photomultipli are added. The crystals form a detector large enou to absorb the total energy of the photons in the giv range. Some applications of the detectors a outlined. L. R. SHEPHE

537.531 : 535.

6652. On the theory of the fine structure of t X-ray absorption spectra of ions in solution. E. VAĬNSHTEĬN. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1059–62 (1953) *In Russian.* English translatio *U.S. National Sci. Found. NSF-tr*-168.

The selective X-ray absorption in a gas is w described by a formula used earlier [Abstr. 9513–

51)]. The modified absorption spectra observed en the same atoms are in solution can be accounted by including the effects of the field of the solvated olecules. The polarizability of the ion concerned also changed. When the linear Stark effect is con- ered a close correspondence between observed and oretical absorption curves is obtained.

A. L. MACKAY

537.531 : 535.34

53. X-ray absorption spectra of zinc in molecules $ZnCl_2$, $ZnBr_2$ and ZnS. K. I. NARBUTT. *Dokl. cad. Nauk SSSR*, **92**, *No.* 2, 273–5 (1953) *In ssian.* English translation, *U.S. National Sci. ound. NSF-tr*-187.

Experimental details of the measurement of X-ray sorption (near the absorption edge) by the vapours zinc compounds contained in a heated quartz be having thin-walled spherical ends are given. ecording was photographic and the photometric cords are reproduced. A. L. MACKAY

537.531 : 535.42

554. X-ray diffraction from built-up multilayers onsisting of only a few monolayers. D. C. BISSET AND IBALL. *Proc. Phys. Soc.* [*London*] *A*, **67**, 315–22 *April*, 1954).

Experiments are described which show that there an exact similarity between optical diffraction from plane grating containing only a few lines and X-ray iffraction from a built-up multilayer, of barium tearate for instance, when the multilayer consists of a ew monolayers. The diffraction maxima given by Bragg's law are accompanied by subsidiary maxima qual in number to $N - 2$ where N is the number of unit cells" (i.e. the number of repeat distances in the irection perpendicular to the plane of the mono- ayers). The formulae for the X-ray case are given nd several experimental examples are cited. A.

537.531.07 : 548.733 : 621.386.1

6655. A fine-focusing X-ray tube with electrostatic focusing. A. ECKHARDT AND L. SEIFERT. *Optik*, **11**, No. 4, 195 (1954). *In German.*

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

6656. Proposal of a synchrotron with a double vacuum chamber. G. SALVINI. Letter in *Nuovo Cimento*, **11**, 555–8 (*May*, 1954).

Particles are first accelerated in a large outer chamber across which a maximum field of perhaps 600 gauss can be obtained. At the end of this stage the beam oscillations will be much reduced and the resulting small-diameter beam is allowed to collapse inwards into an inner chamber of much smaller cross-section, thus enabling a high magnetic field to be reached at much lower cost. Dimensions are worked out for an electron accelerator of 1000 MeV final energy, the change-over occurring at 60 MeV, and problems of magnet and vacuum chamber design are discussed. A saving of a factor of three or more in magnet cost appears possible as compared to a synchrotron of the same performance and of conventional weak-focusing design. J. H. FREMLIN

537.533 : 541.183

6657. On the inhibition of "chemical emission" from fresh metallic surfaces. R. SEIDL AND F. ROUBÍNEK. *Czech. J. Phys.*, **3**, *No.* 4, 309–13 (1953) *In German.*

Describes experiments relating to the emission of negative charged particles from surfaces following adsorption processes. Geiger counter methods were used to follow the emission and its variation with time. J. D. CRAGGS

537.533 : 621.384.622.2

6658. The 15 million electron-volt linear electron accelerator for Harwell. A. Choice of parameters and general design. B. Detailed description of main components and circuits. C. Testing and performance. C. F. BAREFORD AND M. G. KELLIHER. *Philips tech. Rev.*, **15**, 1–26 (*July*, 1953).

The design of the linear electron accelerator was based on a performance of 15 MeV electron energy and 25 mA beam pulse current, with a corrugated waveguide of length about 6 m and using a magnetron operating at 3000 Mc/s with 1·8 MW pulse output. The electron energy to be expected in a system with feedback was computed for different values of the guide parameter a/λ, using a formula which takes into account the heavy beam loading. As a result it was decided to divide the waveguide into two sections each of 3 m length, each with its own feedback loop, and to use a value $a/\lambda = 0{\cdot}168$, the electrons travelling at a stable phase 35° in front of the wave crest. In this way, since it is possible to adjust the phase between wave and electron after the first waveguide section, the frequency sensitivity of the accelerator is reduced to a workable value, having regard to the magnetron stability and practical machining tolerances. To ensure easy assembly, dismantling and re-assembly without readjustment, the corrugated waveguide with its associated parts are mounted on six 3-wheeled trolleys running on rails. A number of components are described more fully, including the corrugated waveguide which consists of 316 cells and whose machining and watercooling are discussed; the electron gun with vacuum valve and the gun filament supply stabilized by means of a "magnetic diode" circuit; the focusing coil system surrounding the guide and divided into six sections, fed from six independent power supply units; the vacuum system, consisting of a diffusion pump of 1500 l/sec unbaffled pumping speed, two rotary backing (or roughing) pumps controlled by magnetically operated valves and an extensive gauging and protective system; the radar type modulator placed on top of the concrete shelter in which the accelerator is housed and feeding 40–50 kV pulses of 2 μsec duration with a maximum jitter of 0·1 μsec to the magnetron and to the electron gun; the rectangular waveguide system evacuated to a low pressure to prevent sparking and incorporating the two feedback bridges (circular magic-Tee's, that are easily adaptable to the power addition ratios other than unity required in this system), the phase shifters which are adjusted by remote control using a specially developed magnetic coupling in order to avoid vacuum seals on moving members and the power monitoring waveguide thermocouples required

for adjusting the phase to give maximum power flux; finally the general lay-out, the details of the protective system and the control and measuring equipment on the control desk. A description is given of the methods used for measuring the electron energy, the beam power (the beam current being derived from these two), the energy spectrum, the X-ray output and the radial variation of electron density in the beam. The energy obtained with an electron beam current of 25 mA when the phases in the feedback loops are carefully adjusted is 14–15 MeV. 50% of the beam power is concentrated on the target within a circle of 8 mm diameter. The maximum X-ray output measured at 1 m distance from the target is 2250 r/min.

A.

537.533.33

6659. Observation on an increase in the scattering power of atoms on electron beams when under electron bombardment. W. Scheffels, B. v. Borries and F. Lenz. *Naturwissenschaften*, **41**, *No.* 4, 83–4 (1954). *In German.*

For background see Abstr. 2480 (1954). Before the caustic section becomes visible by deposition of carbon (formed from the collodion foil) its star shaped inner part is visible as a consequence of another effect, viz. the ionization of a noticeable proportion of the atoms in the regions of the foil subjected to intense bombardment. The ions have a large elastic scattering cross-section and the caustic star appears darker than its surroundings in the shadow picture.

A. H. W. BECK

537.533.331

6660. Calculation of the potential along the axis of electron lenses formed by two co-axial cylinders with different diameters. P. Ehinger. *C.R. Acad. Sci.* [*Paris*] **238**, 879–81 (*Feb.* 22, 1954) *In French.*

Bertram's approximation for the axial potential distribution of a system comprising two coaxial cylinders of equal diameter is extended to the case in which the diameters are not equal by setting up an imaginary conducting film at a point between the cylinders, and applying Bertram's formula to the two regions which it separates. The theory has been experimentally verified to within a few per cent.

A.E.I. RESEARCH LABORATORY

537.533.35 : 539.165.08

6661. Resolving power of the solenoidal beta-ray spectrometer: optimum design considerations. J. Mahanty, S. Pandit and C. Balakrishnan. *J. sci. industr. Res.*, **12 B**, 571–83 (*Dec.*, 1953).

The causes for the spread of the spectral line arising from inherent instrumental factors of solenoidal β-ray spectrometers are rigorously examined on the basis of existing theories, and expressions are obtained for the base width and the intensity distribution of the component line profiles. Necessary conditions are enumerated for compounding the components to produce a resultant with minimum width at half-maximum intensity. A general expression is derived for calculating the position of the entrance slit for various slopes of the locus of the foci for β-particles of different energies. Expressions are given for the critical position and the minimum radius of the counter window. The optimum emission angles for minimum half-width and maximum intensity shown to be 45° 37′ 42·1″ for a point source spec meter and 40° 21′ 42·4″ for one with a disk sou The corresponding values for spreads are calcul in terms of the gathering power and lumin respectively. Data, based on this theory, of characteristics of two spectrometers designed in laboratory are included. The effect of the eccen location of the entrance slit for points which lie on disk source displaced from the axis on the optim source radius and the spread is treated in Append The base width of the resultant line profile is sh to be the sum of the base widths of its component Appendix II.

537.533.72 : 621.385.

6662. Focusing of an electron beam by perio fields. A. M. Clogston and H. Heffner. *J. a Phys.*, **25**, 436–47 (*April*, 1954).

The problem of focusing long electron beams means of magnetic or electric fields which v periodically along the beam is considered. F specific cases are discussed: periodic fields of axially symmetric and quadrupole type with eit electric or magnetic fields employed. The equati of motion are written and solutions obtained wh show beam trajectories corresponding to essenti parallel flow. Under certain specified conditions o small ripples are present. Actual trajectories plotted by the analogue computer are shown a charts and equations are presented to aid in design of practical periodic focusing systems.

537.533.

6663. Elastic scattering of 1-MeV electrons fr aluminum and gold. R. T. Bayard and J. L. Yntem Letter in *Phys. Rev.*, **93**, 1412 (*March* 15, 1954).

The scattering is consistent with the Mott theory a high degree of experimental accuracy. G. E. BROW

537.533.

6664. Electron-electron and positron-electron scatte ing measurements. A. Ashkin, L. A. Page a W. M. Woodward. *Phys. Rev.*, **94**, 357–62 (*April* 1 1954).

A counter experiment is described which measu the absolute differential electron-electron scatteri cross-section in the energy interval 0·6 to 1·2 Me and the absolute differential positron-electron scatte ing cross-section in the energy interval 0·6 to 1·0 Me The ratio of these cross-sections is also measured wi somewhat increased accuracy. The technique measurement combines good resolution with lar energy transfers between the particles to permit sensitive test of the relativistic features of the Møll and Bhabha formulæ. The results verify the Møll formula within the 7% experimental error. T Bhabha formula is verified within the 10% exper mental error. The ratio of the Møller to the Bhabh formula is verified within about 8% experiment error.

537.533.7

6665. Range measurement of low-voltage electron M. Davis. *Phys. Rev.*, **94**, 243–5 (*April* 15, 1954).

Determinations of the ranges of electrons betwee the energies of 600 and 2000 V are difficult to perfor since the short ranges of the particles cannot b

ected by the usual physical methods. A biologically ve molecule such as an enzyme can be used as ector in this energy region, the amount of inactivation in uniform layers of the enzyme being a function he range of the electron. The ranges of the very energy electrons determined in this manner were nd to be considerably less than those predicted by Bethe formula for energy loss, if no allowance for ttering and straggling is made. If about 40% loss range due to this is assumed, then theory and periment are in fair agreement. Alternatively a nstant correction of 100 Å to be subtracted from the culated range brings theory and experiment into eement. A.

537.533.8

666. Influence of the electron energy distribution the mean secondary emission from an insulator. SALMON. Letter in *J. Phys. Radium*, **15**, 190 *March*, 1954) *In French.*

The mean secondary emission coefficient for rex is calculated for use in a study of h.f. breakdown gases at low pressures. The relation between δ and is assumed to be the form $aV^{\alpha}e^{-bV}$ and the dependnce on angle of incidence is taken from Muller's sults. The final result is $\bar{\delta} = 0{\cdot}217Ve^{0{\cdot}563/(V_e + 0{\cdot}0014V_e)^{2{\cdot}563}}$, where $V_e = kT_e/e$ and $T_e =$ ectron temperature in the gas. A. H. W. BECK

537.533.9

667. Excitation and ionization functions in fast ectron collisions. D. RIEDE. *Z. Phys.*, **137**, *No.* 3, 3–17 (1954) *In German.*

The cross-sections for ionization and for the citation of the 4358, 4047, 5461, 5769, 4077, 4347, 790, 4339 Å lines in Hg were measured from 500 to ^{4} V using either photographic or electron multiplier gistration. Together with existing data at lower nergies the results show that above some few hundred olts the excitation functions have all the same form, agreement with theory. W. J. SWIATECKI

537.534

668. Some installations and auxiliary devices for esearch in nuclear physics. M. AGENO, G. CORTELESSA AND R. QUERZOLI. *R.C. Ist. Super. Sanità*, 6, *Pt I–II–III*, 28–38 (1953) *In Italian.*

Some recently installed auxiliary equipment for the 100 kV accelerating plant in the Instituto Superiore di anità is described. This consists of a new installation or making Geiger counters, various devices for high acuum and an electronic safety device to guard gainst unforeseen variations in the load of the ccelerating plant. A.

537.534

669. The acceleration of heavy ions in a fixed-requency cyclotron. D. WALKER, J. H. FREMLIN, W. T. LINK AND K. G. STEPHENS. *Brit. J. appl. Phys.*, **5**, 157–64 (*May*, 1954).

A study has been made of the acceleration of the ions $^9Be^{4+}$, $^{12}C^{5+}$, $^{13}C^{5+}$, $^{13}C^{6+}$, $^{14}N^{6+}$, $^{15}N^{6+}$, $^{16}O^{6+}$ and $^{20}Ne^{9+}$ in a 60 in. fixed-frequency cyclotron. Since the momentum which can be imparted to an ion in a given cyclotron magnet is proportional to the charge carried by the ion, one of the chief problems in accelerating heavy ions to high energies is that of obtaining highly-charged ions. Of particular interest are ions with a final charge which is a multiple of 3, as ions with one-third of the final charge can be extracted from the ion-source and accelerated at closely the same value of magnetic flux-density as the final ion. These ions with one-third of the final charge have a frequency of revolution which is one-third that of the final ions. This preliminary "third harmonic" acceleration of the ions with a low charge gives them such an energy that collisions with gas atoms in the cyclotron tank can strip the ions to the final state of charge desired. This mechanism of acceleration leads to a continuous energy-distribution of the final ions of high charge. The beam current of high energy ions can be increased by increasing the pressure of gas in the cyclotron tank to increase the probability of stripping. A.

537.534 : 536.532

6670. Application of thermocouples to target temperature measurement in the internal beam of a cyclotron. W. J. STURM AND R. J. JONES. Letter in *Rev. sci. Instrum.*, **25**, 392 (*April*, 1954).

It is suggested that the calibration of a thermocouple, when used to measure the temperature of an internal target in a cyclotron, might conceivably be affected (1) by magnetic field, (2) by the r.f. field of the dees, (3) by direct effects of the charged beam, or (4) by changes of couple materials by radiation damage. A chromel-alumel couple was calibrated by measuring the temperatures at which pure samples of lead, aluminium and silver were melted by the 22 MeV proton beam of the ORNL cyclotron. In each case the apparent melting point was within ±3·7°c of the accepted value which was well within the accuracy of the equipment used. J. H. FREMLIN

537.534 : 621.384.611

6671. Concentration of a cyclotron beam by strong focusing lenses. F. B. SHULL, C. E. MACFARLAND AND M. M. BRETSCHER. *Rev. sci. Instrum.*, **25**, 364–7 (*April*, 1954).

A pair of strong focusing magnetic lenses has been used to concentrate a part of the external beam from the Washington University cyclotron. The lenses focus the beam at distances up to more than 4 m beyond the end of the cyclotron. This produces approximately an eightfold improvement in beam intensity. A.

537.534 : 621.384.62

6672. Grid-focused linear accelerator dynamics. J. S. BELL. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. T/M95*, 33 *pp.* (1954).

A general account is given of the dynamics of a linear proton accelerator of the Berkeley type. Particular attention is paid to the effect of phase oscillation on the radial motion. Under certain circumstances, notably when the frequency of radial oscillation is just half that for phase oscillation, resonance occurs. Numerical integrations for a specific design in which this resonance is swept over in the course of the acceleration show considerable build-up of the radial motion. A perturbation theory gives approximate formulae which should enable the importance of the resonance to be estimated for other cases. Some approximate methods are developed for estimating the importance of resonance without doing numerical integrations for each case.

The method of variation of parameters is used. An analysis is given of the importance of the grid wire spacing. If the spacing can be large then the transparency of the grid can be better. A.

537.534 : 621.384.62

6673. Alternating gradient electrostatic focusing for linear accelerators. L. C. TENG. *Rev. sci. Instrum.*, **25**, 264–7 (*March*, 1954).

The properties of the focusing systems using alternating convergent and divergent electrostatic lenses which were proposed by Courant *et al.* and Blewett [Abstr. 907–8 (1953)] are studied in detail, applied to Alvarez type of linear accelerators. It is found that the introduction and the removal of the focusing force of the system can be made approximately adiabatic by using half-length injection and extraction lenses. The appropriate choice of the parameters of the lenses in practical cases and the behaviour of the ion beam going through such a system are discussed. The results can easily be reinterpreted to apply to magnetic lens systems. A.

537.534 : 621.384.62

6674. Achromatic beam translation systems for use with the linear accelerator. W. K. H. PANOFSKY AND J. A. MCINTYRE. *Rev. sci. Instrum.*, **25**, 287–90 (*March*, 1954).

The beam of a linear accelerator has desirable geometrical properties but frequently contains secondaries produced in the machine and has an unsuitable energy spectrum. Two systems have been designed which translate the accelerator beam without energy dispersion. In the one system, now in operation, the emergent beam has an "energy focus," i.e. a point at which the initial beam geometry is reproduced independent of energy. The second system is designed to produce a beam translated but otherwise unmodified in geometry, independent of beam energy to the first order. Both systems permit easy control of energy width and produce a beam free from secondaries. A.

537.534.3

6675. Mechanical precision required in electrostatic analysers. M. HOYAUX AND J. GEETS. Note in *J. sci. Instrum.*, **31**, 149–50 (*April*, 1954).

In order to determine the effect of machining irregularities in the separation of the electrodes of an electrostatic analyser, two analysers of non-uniform electrode separation are considered, and compared with the ideal analyser of constant electrode separation. A 90° analyser is considered, of radius 1 m and electrode separation 1 cm. The gap is split into 18 sections and irregularities are considered to occur as step functions between these sections. It is shown that the focusing and resolving power of the analyser is little affected by gap irregularities up to 0·1 mm, although a much higher constancy of electrode separation would be required for an absolute instrument. D. R. CHICK

537.534.74

6676. Cross sections for *p–p* scattering at 330 and 225 MeV. O. CHAMBERLAIN, G. PETTENGILL, E. SEGRÈ AND C. WIEGAND. Letter in *Phys. Rev.*, **93**, 1424 (*March* 15, 1954).

The differential cross-sections, deduced from the results of a transmission experiment, were found to be $3{\cdot}72 \pm 0{\cdot}15$ mb/steradian at 330 MeV and $3{\cdot}56 \pm 0{\cdot}15$ mb/steradian at 225 MeV. J. M. CASSELS

537.534

6677. Experiments with high-energy polarised protons. O. CHAMBERLAIN, E. SEGRÈ, R. TRIPP, C. WIEGAND AND T. YPSILANTIS. Letter in *Phys. Rev.*, **93**, 1430 (*March* 15, 1954).

A highly polarized proton beam was obtained by scattering 340 MeV protons through about 20° in beryllium or carbon. A second scattering by hydrogen or carbon gave large right/left asymmetries. Both elastic and "quasi-elastic" scattering in carbon gave rise to polarization effects. J. M. CASSELS

537.534.

6678. Passage of heavy particles through matter. S. K. ALLISON AND S. D. WARSHAW. *Rev. Mod. Phys.*, **25**, 779–817 (*Oct.*, 1953).

A brief introductory discussion is given of the stopping of charged particles by ionization, the Bethe–Bloch equation, straggling, and of the associated phenomena of charge exchange and chemical additivity. The measurements in the two energy ranges < 2 MeV and > 2 MeV, are considered separately. In the low-energy region the measurements and results for the absolute stopping power are discussed, the stopping in metals and solids being considered apart from that in gases. A survey of experiments on the capture and loss of electrons by ions in the energy range 20–7000 keV is given. The high-energy results are mainly measurements of range-energy relations. A bibliography of 109 items is given, which includes only such work on range-energy relations which has been completed since the review of Taylor [Abstr. 2767 (1952)]. J. HUGHES

537.534.

6679. On the relative stopping power of certain substances for Po-α particles. B. YARAMIS. *Rev. Fac. Sci. Univ. Istanbul A*, **18**, 369–83 (*Oct.*, 1953).

A special mica end-window G.M. counter was used. The relative stopping powers were: C, 1·052; CO_2, 1·500; CH_4, 0·894; C_2H_4, 1·34; C_2H_2, 1·120; C_6H_6 (vapour), 3·364. The relative stopping power for carbon was calculated from CO_2 and O_2 by Bragg and Kleeman's additive law, giving 0·896. The stopping power of carbon had not previously been measured directly and was obtained from carbon compounds only. In this investigation the decomposition of benzene was used to obtain carbon films deposited on mica foil, 1–1·5 mg/cm² thick, and the relative stopping power of these pure and homogeneous carbon films was found to be 0·895.

537.534.7

6680. A device for determining relative stopping powers for natural alpha particles. R. H. ELLIS, JR. *Rev. sci. Instrum.*, **25**, 336–40 (*April*, 1954).

A device is described by which the stopping power for polonium α-particles of thin solid or liquid films can be compared with that of gases. An optical system measures film thickness, and the relative stopping power is inferred from the decrease of range which results when a thin film is inserted across a beam of α-particles. The device has been used with

ystyrene and acetylene and a relative stopping wer of 0·99 ± 0·02 is observed. A.

537.534.75

31. Mean excitation potentials. D. O. CALDLL AND J. R. RICHARDSON. *Phys. Rev.*, **94**, 79 pril 1, 1954).

Previous experimental data of Sachs and Richardn [Abstr. 4153 (1953)] on the most probable energy s of 18 MeV protons on passing through thin foils ve been used in connection with the theory of mon to calculate the mean excitation potential *I*. e result for aluminium is $I = 164 \pm 3$ eV. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

82. A transmission Čerenkov counter. S. J. NDENBAUM AND A. PEVSNER. *Rev. sci. Instrum.*, **25**, 5–6 (*March*, 1954).

A high-efficiency transmission-type Cherenkov ounter is described for use in counter telescope work. ange curves for liquids of different indices of reaction are presented. A.

537.542

683. The new counters. S. C. CURRAN. *Sci. rogr.*, **42**, 32–45 (*Jan.*, 1954).

A non-specialist survey of progress, characteristics nd applications. Forty-seven refs.

537.542

684. A gas-flow X-ray diffraction counter. U. W. RNDT, W. A. COATES AND A. R. CRATHORN. *Proc. hys. Soc.* [*London*] *B*, 357–9 (*April*, 1954).

Gives a detailed description of an "all-metal" type f gas flow counter, which provides 70% detection fficiency for Cu *Kα* radiation. A CO_2–A (2½%–97½%) as mixture was used. J. D. CRAGGS

537.542

685. Long life Geiger counters. H. SHERMAN AND . R. HEIRTZLER. *J. sci. industr. Res.*, **12 A**, 370–2 *Aug.*, 1953).

Briefly summarizes certain properties of long-life elf-quenched counters, containing NH_3 or a halogen as. J. D. CRAGGS

537.542

686. Electron transit times in Geiger counters. . R. HEIRTZLER. *Rev. sci. Instrum.*, **25**, 243–5 *March*, 1954).

The transit time of an electron between the cylinder nd the central wire of a self-quenching Geiger ounter has been measured as a function of several ounter parameters. The partial pressure, total pressure and nature of the filling mixture were varied. The measured times are presented in graphic form. A.

537.542

6687. On liquid argon ionization chambers of centimeter size. J. H. MARSHALL. *Rev. sci. Instrum.*, **25**, 232–7 (*March*, 1954).

A parallel-plate chamber with electrode separation variable from 2 mm to 2 cm has been used to measure recombination, attachment and energy resolution for β-ray ionization in liquid argon. A collecting voltage up to 30 kV was used without introducing spurious pulses. Amplifier noise sets the lower limit to β-ray detection at about 150 keV and limits the energy resolution to about 100 keV (full width at half maximum at any energy). A.

537.542

6688. On locating particles by means of scintillation counters. G. CORTELLESSA. *R.C. Ist. Super. Sanità*, **16**, *Pt I*, 5–12 (1954) *In Italian.*

The effect of the existence of an energy transfer in a scintillator is worked out, regarding the possibility of the localization of fast particles with scintillation counters. A.

537.542

6689. Aerial prospecting with scintillation counters. G. COWPER. *Nucleonics*, **12**, 29–32 (*March*, 1954).

An airborne γ-ray detector employing two large NaI(Tl) crystals whose photomultiplier output pulses are added, amplified and counted on a rate meter, is described. A special feature in this equipment is a simple cancellation circuit for eliminating large cosmic-ray pulses. The conditions for optimum response, in the detection of a localized source, are discussed. L. R. SHEPHERD

537.542

6690. Large-volume liquid scintillators: their applications. F. B. HARRISON, C. L. COWEN, JR AND F. REINES. *Nucleonics*, **12**, 44–7 (*March*, 1954).

The characteristics and usefulness of large-volume liquid scintillation detectors are outlined. A counter having a volume of 300 litres in a right cylindrical stainless steel tank painted white on the inside and viewed by 90 photomultipliers is described. A toluene-terphenyl-αNPO solution has been used as the scintillator, with 7½% Cd propionate and 14% methanol added, if neutron detection is intended. The detector is used in conjunction with electronic circuits providing pulse height and time-delay analysis. Energy calibration of the detector is obtained by observing the passage of relativistic particles right through the liquid (~115 MeV) or the decay of μ-mesons (end-point energy 53 MeV) and time-delay calibration is achieved by observations on the 2·1 μsec decay of the μ-meson. L. R. SHEPHERD

537.542 : 537.531 : 539.166.08

6691. Scintillation spectrometry of continuous γ- and X-ray spectra below 1 MeV. K. LIDÉN AND N. STARFELT. *Ark. Fys.*, **7**, *Paper* 36, 427–57 (1954).

A detailed analysis is attempted of the factors influencing the performance of the scintillation counter for γ- and X-ray spectrometry. Considerations are given to source geometry, photon back scattering, *K*-radiation from Pb screens, correction for Compton effect, escape of *K* X-rays from iodide crystal and errors due to photoelectric efficiency. G. F. J. GARLICK

537.542 : 537.533.9

6692. Large scintillators, Čerenkov counters for high energies. A. KANTZ AND R. HOFSTADTER. *Nucleonics*, **12**, 36–43 (*March*, 1954).

The need for large scintillation or Cherenkov counters in the spectrometry of very high energy electrons or quanta is stressed. Experiments to determine the energy loss of a beam of 185 MeV

electrons in large stacks of flat plates of C, Al, Cu, Sn and Pb, using scintillation probes of "equivalent" material, are described. The results obtained are used to determine the sizes of scintillating crystals or Cherenkov detectors required for total absorption spectrometry and also to calculate the expected pulse height distributions. The problem of light collection from such large scintillators is discussed.

L. R. SHEPHERD

537.542

6693. New studies of a spark counter. A. RYTZ. *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 261–4 (*Dec.*, 1953) *In French.*

537.542

6694. Mechanical addition-apparatus for impulse-analysers and similar purposes. H. GLÄTTLI, P. STOLL AND H. WIDMER. *Helv. phys. Acta*, **27**, *No.* 2, 144–8 (1954) *In German.* Shorter version in *Rev. sci. Instrum.*, **25**, 393 (*April*, 1954).

An apparatus, operating with small steel balls, calculates the differences between the outputs of several discriminators. The result is shown graphically, by the balls themselves in a series of vertical columns, and can be followed during the measurement. Resolving time is $\frac{1}{20}$ sec, but any value may be obtained by interconnection of scaling circuits. A.

537.542 : 621.374.32

6695. A multichannel pulse-height analysis system utilizing a 35-mm film record. W. A. HUNT, W. RHINEHART, J. WEBER AND D. J. ZAFFARANO. *Rev. sci. Instrum.*, **25**, 268–74 (*March*, 1954).

A system is described for obtaining quantitative amplitude distribution data for events which can be displayed as proportional voltage pulses for visual observation on a cathode-ray oscilloscope. The use of a circuit which intensifies the top of each flattened pulse during display permits photographing the events as dots on a moving 35 mm film at rates of 20 000 per sec or greater. An automatic electromechanical "reader" is described which will scan the resulting film and produce a printed record of the number of events in each of 100 discrete "channels" with an accuracy comparable to the best available from other "kicksorting" schemes. A spectrum of over 500 000 events can be recorded on 100 ft of film. A.

537.542 : 621.374.32 : 621.317.79

6696. A multichannel time-analyzer for precision work. G. VON DARDEL. *Appl. sci. Res. B*, **3**, *No.* 3, 209–29 (1953).

20- and 40-channel versions of a reliable time-analyser have been constructed and used for a number of investigations. Non-uniformity of channel width is eliminated by a special circuit, so that time distributions can be measured with high precision. Circuit diagrams are given for the various circuits, and their performance is discussed. Convenient methods of testing the equipment are described. The possibilities of extending the range of application of the apparatus by suitable modifications are discussed. A.

537.542

6697. An improved Wilson cloud-chamber apparatus for the measurement of beta-ray scattering. J. ALLEWAERT AND J. VERHAEGHE. *Meded. K. Vlaam. Acad. Wetensch.*, **15**, *No.* 12, 12 *pp.* (1953) *In Flemi*

Describes the construction of two apparatus the automatic recording of the scattering of cosmic-beta-rays in thin films in different gases. Electro circuits are described which operate the lig magnetic field, camera and the Wilson chamb The piston movement is controlled by the use o vacuum pump and a relay-operated valve. J. M. HOU

537.

6698. An improvement in high speed expansion [a] counter controlled cloud chamber. I. KITA. N in *J. Phys. Soc. Japan*, **8**, 803–4 (*Nov.–Dec.*, 1953).

Describes a valve circuit which reverses the curr through the cloud chamber release magnet. using this arrangement the decay time of the field the release magnet was reduced from 14 to 4 msec. H. ELL.

537.

6699. A fast-compression magnetic cloud cham and some auxiliary control circuits. C. R. EMI *Rev. sci. Instrum.*, **25**, 221–5 (*March*, 1954).

The primary considerations which were emplo in the design of a cloud chamber for a recent exp ment were to incorporate into its characteristics high a magnetic field strength and as short a cy time as practical, and a sequencing control circ which would be both simple to adjust and relia over long periods of data-taking time. A descripti is given of the important constructional details of t cloud chamber as well as a discussion of the m important auxiliary circuits. These are: the cont circuits for the Diesel-driven generator which suppl the current for the cloud-chamber field coils, pulsed light system for photographic illumination a the temperature regulating circuit for the clo chamber.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 539.

6700. Ionization by relativistic μ-mesons in oxyge S. K. GHOSH, G. M. D. B. JONES AND J. G. WILSO *Proc. Phys. Soc.* [*London*] *A*, **67**, 331–42 (*April*, 195

The specific ionization in oxygen near atmosphe pressure has been measured over the momentu range 3×10^8 eV/c $< p <$ 3×10^{10} eV/c, excluding co lisions involving energy transfers greater than 1 ke The measurement was based upon drop counts in t positive ion column of tracks in a cloud chamb independent of the system used to measure mome tum, Modification of ionization due to polarizatio phenomena is shown to become important at momen greater than about 6×10^9 eV/c.

537.56

6701. The ionization potential [V_I] of bromin J. KUIPER AND D. VAN ZOONEN. Letter in *Appl. sc Res. B*, **3**, *No.* 4–5, 390–2 (1953).

Breakdown potentials V_B were measured for vario admixtures of A and Br at a total pressure 15 mm Hg. The curve of V_B against pressure of

ws a minimum at 10^{-1} mm Hg. This indicates V_I is lower than the metastable level of A, 5 eV. Addition of more than 2·5% N_2 to the ture causes the minimum to disappear, probably to the destruction of A metastable atoms by N_2. J. DUTTON

537.563

2. The mass spectrum of monosubstituted derivatives of benzene: phenol, monodeutero-phenol, thiophenol, aniline. J. MOMIGNY. *Bull. Soc. Roy. Sci. Liège*, **22**, 541–60 (*Dec.*, 1953) *In French.*

The mass spectra of the ions produced by electronic impact on C_6H_5OH, C_6H_5OD, C_6H_5SH and $C_6H_5NH_2$ are tabulated and figuratively represented. There is evidence of atomic migration within the molecule accompanied by rupture of the molecule with formation of fragmentary ions. G. I. W. LLEWELYN

537.564

03. Total ionization of α-particles of Po in mixtures of gases. G. BERTOLINI, M. BETTONI AND A. BISI. *Nuovo Cimento*, **11**, 458–67 (*May*, 1954).

Measurements have been made on the ionization produced by Po^{210} α-particles in mixtures of: A–H_2, A–N_2, A–CH_4, A–C_2H_5OH and A–C_6H_6. The plot of the ionization *versus* the concentration of the components of the mixture confirm the hypothesis of Haeberli and co-workers on the necessity of taking into account the ionization of δ-rays for the theoretical evaluation of the experimental results. They also confirm the hypothesis put forward by others on the existence of an interaction between excited atoms of argon and the molecules of the foreign gas. In this process the molecule of the gas is ionized and an electron is collected in the chamber. The measurements were taken by means of a gridded ionization chamber and a fast recording circuit that could amplify and analyse the individual pulses corresponding to the ionization of individual α-particles in the chamber. A.

537.568

704. A correction of the Thomson-formula for the coefficient of three-body-recombination [α] between electrons and ions. C. T. J. ALKEMADE. Letter in *Physica*, **20**, 129–30 (*Feb.*, 1954).

Corrections to the Thomson formula [*Phil. Mag.*, **7**, 337–78 (*Feb.*, 1924)] (arising from considerations of the fluctuating direction of motion of the electrons and of the chance of a given number of electron-atom collisions in a given interval of space), give $\alpha \simeq (8kT/\pi m)^{\frac{1}{2}} 2\pi r_0^2 (r_0/\eta^{\frac{1}{2}} l_k)^{\eta-1}/(\eta^{-1})!$ where η is the mean fractional energy loss when an electron collides with an atom, l_k is the mean kinetic free path and the other symbols have their usual meaning. J. DUTTON

537.581

6705. Temperature dependence of periodic deviations from the Schottky line. G. A. HAAS AND E. A. COOMES. Letter in *Phys. Rev.*, **93**, 1421 (*March* 15, 1954).

Experimental evidence for the increase in maximum deviation from the Schottky line with variation in (T^{-1}) is given for a patch-free specimen of polished Mo. A. H. W. BECK

537.583

6706. On the activation of thoria emitter by zirconium. S. FUKAGAWA. *Mem. Coll. Sci. Univ. Kyoto A*, **26**, 45–62 (*Oct.*, 1950).

Studies tungsten filaments coated with a layer of zirconium powder before pasting with powdered thoria. When Zr is not present the emission drops off sharply at $\simeq 1700°K$, but with Zr there is no sudden drop and emission $\propto 1/T$ down to $\simeq 1400°K$. The sudden change in the first case is due to the reduction of insufficient thoria while in the second case diffusion is the only limiting factor. The work function range was from 1·79–2·65 eV. The activation energy for diffusion of Th in ThO was $\simeq 3·8$ eV and the activation energy for reduction of ThO on W was $\simeq 5·3$ eV. A. H. W. BECK

537.583

6707. On the activation of thermionic cathodes of thoria and zirconia. G. MESNARD. *J. Phys. Radium*, **15**, 151–5 (*March*, 1954) *In French.*

Experiments to elucidate the nature of the activation are described. The effects produced by deposition on different support wires seem to indicate that reduction by the latter is the major factor. However, when thoria is coated over zirconia some activation is observed and this means that the effects of thermal dissociation are not negligible. A. H. W. BECK

537.583 : 541.124

Reduction of SrO by methane on Pt and Ni filaments. *See Abstr.* 6956

COSMIC RAYS 537.591

537.591

6708. The origin of cosmic rays. P. MORRISON, S. OLBERT AND B. ROSSI. *Phys. Rev.*, **94**, 440–53 (*April* 15, 1954).

The isotropy and composition of the primary cosmic radiation suggest that cosmic-rays are trapped within the Galaxy for an average time of the order of 10^6 years—a long time compared with the time of escape along straight-line paths, but short compared with the mean life against nuclear collisions with interstellar matter. If one accepts this conclusion, it appears possible to account for the observed properties of cosmic-rays under the assumption that cosmic-rays acquire their large energies through a gradual acceleration in space, such as suggested by Fermi. In contrast to the original Fermi theory (which denied any possibility of escape from the Galaxy), the energy spectra of protons and heavier nuclei are now found to be approximately the same, and the required injection energies very modest for all components. A much faster rate of acceleration must be assumed, however, than the original theory required. The consequences of the above assumptions are developed in some detail on the basis of a specific model, describing the motion of cosmic-rays through the Galaxy as a random motion between scattering centres represented by moving magnetized clouds. The astrophysical implications of the assumptions, and the plausibility of the model, are briefly discussed. A.

537.591.1

6709. Determination of the number of slow π and μ mesons in cosmic rays at various altitudes. Kh. P. Babayan, I. I. Zinger and N. A. Marutyan. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 2, 263–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-184.

The ratio of the numbers of π- to μ-mesons of energies up to 12 MeV has been determined at altitudes 3980, 3250 and 960 to 1950 m using nuclear emulsions exposed for between 12 and 20 days. The ratios n_π/n_μ are $0{\cdot}69 \pm 0{\cdot}29$, $0{\cdot}57 \pm 0{\cdot}11$ and $0{\cdot}34 \pm 0{\cdot}15$ respectively. H. ELLIOT

537.591.1

6710. Frequency of slow cosmic-ray μ-mesons stopped in the photographic emulsions at 23 m.w.e. underground. S. Kaneko, T. Kubozoe and M. Takahata. *J. Phys. Soc. Japan*, **9**, 147–9 (*March–April*, 1954).

The absolute frequency of slow μ-mesons stopped in emulsions at a depth of 23 m.w.e. underground was measured. The result is $0{\cdot}22 \pm 0{\cdot}03$ particles cm^{-3} day^{-1}, which is greater than the value published by George and Evans by a factor of about 2·5. A.

537.591.15

6711. Solution of the *G*-equations of Janossy for the cosmic showers. J. Łopuszański. *Acta phys. Polon.*, **12**, *No.* 2, 156–59 (1953) *In German.*

A method applicable to the solution directly for the generating function under neglect of ionization loss is outlined. For $\varepsilon > 1$, the solution can be found, and for $\varepsilon < 1$ this solution can be used to begin a step by step process which requires n steps to find the solution for $\varepsilon > 1/n$. G. E. BROWN

537.591.15

6712. On the production of meson showers on hydrogen nuclei. O. Haxel and H. Schultz. Note in *Z. Naturforsch.*, **9a**, 178–80 (*Feb.*, 1954) *In German.*

A shower detector consisting of 3 trays of counters embedded in Pb was used to compare the frequency of showers produced in layers of C, Al and paraffin of 0 to 70 g/cm.^{2} No differences were found for the 3 materials (in 1 case to $\pm 2\%$), showing that: (*a*) for $A < 27$ nucleons produce showers additively, (*b*) showers are produced also on H nuclei.

W. J. SWIATECKI

537.591.5

6713. High energy particles in thunderstorms. J. Clay. *Proc. K. Ned. Akad. Wetensch. B*, **55**, *No* 5, 449–50 (1952)

It is pointed out that the increase in cosmic-ray intensity observed during thunderstorms in Amsterdam may not be due to the acceleration of electrons to high energies, as previously suggested, but to the differential effect of the thunderstorm electric field on the unequal numbers of positive and negative mesons.

H. ELLIOT

537.591.5

6714. Sidereal correlation of high-energy cosmic rays. F. J. M. Farley and J. R. Storey. Letter in *Nature* [*London*] **173**, 445 (*March* 6, 1953).

Extensive air showers have been recorded in Auckland over a period of one year using three counter trays, each of area 2360 cm^2, placed at t corners of an equilateral triangle with 4 m sid A total of 3×10^5 events were recorded and the resu show a solar daily variation of $1{\cdot}46 \pm 0{\cdot}16\%$, wi a maximum at about 0300 hr local time and a sider variation of amplitude $1{\cdot}06 \pm 0{\cdot}16\%$ with a ma mum at $19{\cdot}3 \pm 0{\cdot}6$ hr local sideral time. The ti of maximum corresponds to the time of transit of galactic centre. H. ELLI

537.591

6715. The absolute intensity of cosmic rays geomagnetic latitude 25°N. Y. Kitamura A O. Minakawa. Letter in *Progr. theor. Phys.*, 239–40 (*Aug.*, 1953).

The absolute intensities with and without le absorber have been determined for zenith ang $\theta = 0°$, 25°, 39° and 45° using counter telescop It is shown that the intensity varies as $\cos^{2\cdot1}\theta$ the hard component and as $\cos^{2\cdot8}\theta$ for the s component. H. ELL

537.59

6716. Observations of cosmic-rays with nucl emulsions. K. Kimura, S. Tokunaga, R. Ishiw and K. Yuasa. *Mem. Coll. Sci. Univ. Kyoto A*, 167–81 (*Oct.*, 1950).

The frequency distribution of stars as a junction number of prongs has been determined at 284 altitude and the results are compared with those other workers. H. ELL

537.59

6717. Observation of cosmic ray stars in nucl emulsion at Mt. Zaō. M. Kimura, N. Mutu Y. Ōnuki and K. Yomogida. *Sci. Rep. Tôhc Univ. First Ser.*, **35**, 185–94 (*Jan.*, 1952).

The frequency distribution as a function of numl of prongs is given for stars observed at 176 altitude. A total of 63 stars was examined of wh 5 were double stars. H. ELL

537.59

6718. On the transition effect of the neutron-p ducing component of cosmic rays in carbon. Pfotzer and H. M. Weiss. *Naturwissenschaft* **41**, *No.* 5, 107–9 (1954) *In German.*

The neutron intensity from a Pb radiator below variable thickness of carbon had a maximum at carbon thickness of 9 cm. This maximum w observed with Pb radiator thicknesses of both and 2 cm. J. HUGH

537.59

6719. On "An unusual star" by Nakagawa *et* O. Minakawa and J. Nishimura. *J. Phys. So Japan*, **9**, 137–9 (*Jan.–Feb.*, 1954).

See Abstr. 4684 (1954). A critical examination the characteristics of the star. There is no justificati for the conclusion of a κ-meson primary.

W. J. SWIATEC

537.591

6720. Remarks on recent analyses of cosmic ray je C. C. Dilworth, S. J. Goldsack, T. F. Hoang A L. Scarsi. Letter in *Nuovo Cimento*, **11**, 424 (*April*, 1954).

Replies to criticism [Abstr. 5778 (1954)] of earlier paper on cosmic-ray jets in which the tunn

...del of Roesler and McCusker was used to interpret ... experimental data. H. ELLIOT

537.591.8

...1. On the interaction of μ-mesons with matter at ... energies. P. E. ARGAN, A. GIGLI AND S. SCIUTI. *...ovo Cimento*, **11**, 530–8 (*May*, 1954).

The production of penetrating showers at depths ... 50 and 200 m water equivalent by high-energy ...nesons has been studied with a counter hodoscope. ...e values of the cross-section found (in lead) for ...nts of this kind are consistent with those expected ...uming an electromagnetic interaction mechanism, ...cording to which the penetrating showers can be ...tiated by the photoproduction of a π-meson or by ...igh-energy recoil nucleon. The agreement between ... measured and calculated cross-section is very ...od, if it is assumed that the total photonuclear ...ss-section, $\sigma_{\gamma tot} = 3 \times 10^{-28}$ cm^2/nucleon, remains ...changed even at the high energies concerned at the ...pths considered. Therefore it seems unnecessary ... invoke a new interaction in order to explain the ...perimental results. A.

MAGNETISM 538

538.082 : 621.317.42

...22. Three methods of measuring magnetic fields. ... Measurement based on the generator principle. ... F. JÜRGENS. II. Measurement of the field on the ...is of magnetic electron lenses. A. C. VAN DORSTEN ...ND A. J. J. FRANKEN. **III. Measurement by the ...roton resonance method.** H. G. BELJERS. *Philips ...ch. Rev.*, **15**, 49–62 (*Aug.*, 1953).

Three instruments for the measurement of magnetic ...elds, based on three entirely different principles, are ...escribed. The first of these makes use of an ...xtremely small coil (outside dia. 1 mm, length ...·5 mm), mounted on the shaft of a small synchronous ...otor and rotated with constant angular velocity in ...e field to be measured. The voltage generated is ...ollected by contact rings and springs and is taken ...o an amplifier and then rectified. The resultant d.c. ...oltage is a measure of the magnetic induction. The ...nfluence of the mains frequency on the induced ...ignal voltage is compensated by a suitable response ...urve of the amplifier. The measuring range is very ...vide, viz. 10^{-4} to 3 Wb/m^2 (1–30 000 gauss.), and the ...ccuracy is 3%. The second instrument was developed ...specially for the measurement of fields along the ...xis of magnetic electron lenses. A long thin solenoid, ...he winding direction of which is reversed at the ...centre, is suspended vertically by two flat springs and ...s mounted so as to coincide with the axis of the ...electron lens. When a constant 50 c/s alternating ...current is passed through the solenoid, an alternating ...force acts upon the coil, this being proportional to the ...magnetic induction at the point where the winding ...changes direction. In consequence, the solenoid ...vibrates vertically, and this vibration is communicated ...to the sapphire needle of a gramophone pick-up. The ...a.c. voltage thus obtained, which is amplified, is a ...measure of the induction. By this method the field ...at any point on the axis of a magnetic electron lens can be measured simply and quickly with an error of <1%. In the third method, a small container of water is placed in the field to be measured. A weak alternating field set up at right angles to this field, brings the hydrogen nuclei of the water molecules into resonance. The frequency at which this proton resonance occurs is proportional to the strength of the field to be measured (30 Mc/s in a field of 0·7047 Wb/m^2). Measurement of the magnetic induction is thus reduced to measurement of this resonance frequency, which can be carried out with a high degree of accuracy. The method is very suitable for the accurate, absolute measurement of strong homogeneous magnetic fields (error <0·01%). The measuring range is 0·16–0·82 Wb/m^2. Another model has a range of 0·5 to 1·4 Wb/m^2. This method has been employed in the Philips laboratories to check the stability of a large permanent magnet used for calibration purposes. A.

538.082 : 621.317.42 : 621.317.72

6723. An electronic voltage integrator. R. MADEY AND G. FARLY. *Rev. sci. Instrum.*, **25**, 275–9 (*March*, 1954).

An electronic voltage integrator has been used in the magnetic measurements programme of the Berkeley Radiation Laboratory since 1948. The device can explore magnetic fields in the range from 500 to 15 000 gauss. to an accuracy of better than one per cent. The heart of the integrator consists of a direct-coupled high-gain amplifier connected in a "feedback time-constant" circuit. The amplifier uses the cascode connection, the filament drift compensation circuit of Miller and an internal positive feedback adjustment for "infinite" gain. Some other features of the integrator amplifier include low grid current operation, large linear output range and provision for adjustment of the input and the output voltages to zero potential when no signal is present. A.

538.082.743

6724. The effects on measurements with the Förster probe of the proximity of a ferromagnetic body. F. BRANDSTAETTER. *Elektrotech. u. Maschinenbau* [*EuM*] **70**, 484–7 (*Nov.* 1, 1953) *In German.*

If carbonyl iron in paraffin is placed in a long solenoid and stray-field measurements are made with the probe [Abstr. 2824 (1952)], at specific field strengths, the results obtained differ widely from the calculated values as the iron content is increased beyond 35%. No meter reading is obtained when the solenoid is empty—as is to be expected—neither can the discrepancies be attributed to demagnetization effects. Finally, the test figures are consistent in as much as they remain ∝ the magnetizing force for a fixed percentage of iron. The explanation given, therefore, is that the probe's own flux field is distorted by the proximity of the high-permeability material. H. G. M. SPRATT

538.114

6725. The extension of the spin-wave theory of ferromagnetics to higher temperatures. G. HEBER. *Z. Naturforsch.*, **9a**, 91–7 (*Feb.*, 1954) *In German.*

Modifies the original Bloch treatment by a more accurate determination of the spin-wave energies when there is more than one reversed spin, and by

using the correct energy range of integration in the statistical mechanical treatment. The author states that the discussion suffers from the drawbacks that (1) the creation and annihilation operators are replaced by their eigenvalues, (2) the energy density of spin-wave states is a function of temperature. In one approximation the relative magnetization ζ is given by the relation $(1-\zeta)(1+\zeta)^{\frac{1}{2}} = AT^{\frac{3}{2}}$, where A is a constant. This relation is stated to agree closely with the original Bloch relation for T less than $\frac{1}{3}$ the Curie temperature. E. P. WOHLFARTH

538.114

6726. On the spin-lattice relaxation [in ferromagnetic substances] at extremely low temperatures. K. SUGIHARA. Letter in *Progr. theor. Phys.*, **10**, 234–5 (*Aug.*, 1953).

Shows theoretically that for spin-lattice relaxation phenomena at very low temperatures the interaction of the spin-waves with transverse lattice waves is important. See also Abstr. 8537 (1953).

E. P. WOHLFARTH

538.22 : 539.11

6727. Magnetic susceptibilities of ternary magnesium alloys and their meaning from the standpoint of the electron theory of metals. H. KLEE AND H. WITTE. *Z. phys. Chem.*, **202**, 352–78 (*Jan.*, 1954) *In German.*

Reports measurements of susceptibilities of the Laves phases in $MgCu_2$–$MgZn_2$, $MgCu_2$–$MgAl_2$, $MgCu_2$–$MgSi_2$ and $MgZn_2$–$MgAl_2$. The susceptibility of the conduction electrons is calculated on the Brillouin zone model, using estimated Fourier coefficients of the crystal potential, for the case of $MgCu_2$–$MgZn_2$. When the Fermi surface approaches a prominent zone boundary there are anomalies in the susceptibility which agree qualitatively with the observations. Certain phase boundaries are found to occur when prominent zones are getting nearly full.

W. M. LOMER

538.221

6728. The tensor formulation of ferromagnetic resonance. J. A. YOUNG, JR AND E. A. UEHLING. *Phys. Rev.*, **94**, 544–54 (*May* 1, 1954).

The tensor formulation of electromagnetic wave propagation in a conducting ferromagnetic medium is used to describe resonance phenomena in a test cavity under two different conditions of magnetization. The new formulation alters the prediction with respect to the shape of the resonance curve in the case of perpendicular magnetization and it predicts a different ratio of energy absorptions in the cases of parallel and perpendicular magnetization than is given by a formulation based on the concept of a permeability coefficient. When interpreted according to the new formulation the results of simultaneous measurements of frequency shift and energy absorption under different conditions of magnetization are found to be consistent with each other. Such consistency is not achieved on the basis of earlier formulations. A.

538.222

6729. On the magnetic structure of manganese antimonide. K. KOMATU. Letter in *Progr. theor. Phys.*, **10**, 579–81 (*Nov.*, 1953).

Gives a theoretical interpretation of the temperature dependence of the paramagnetic susceptibility [illegible] Mn_2Sb above the Curie point. A molecular fi[illegible] model, differing in detail from that of Néel and giv[illegible] worse agreement with experiment, is used.

E. P. WOHLFAR[illegible]

538.[illegible]

6730. Magnetic properties of a bivalent silver s[illegible] H. M. GIJSMAN, H. J. GERRITSEN AND J. VAN [illegible] HANDEL. *Physica*, **20**, 15–16 (*Jan.*, 1954).

Paramagnetic resonance measurements on Ag[illegible] persulphate stabilized with pyridine gave $g = 2\cdot[illegible]$ $2\cdot09$ and half-widths 50–75 oersteds for the ra[illegible] $4\cdot2$ to 297°K for both the pure salt and that dilu[illegible] with Cd^{++}. Susceptibility measurements sho[illegible] Curie's law to hold to $1\cdot6$°K. D. H. WHIFF[illegible]

538.[illegible]

6731. Paramagnetic susceptibility of solid oxyg[illegible] E. KANDA, T. HASEDA AND A. ŌTSUBO. Let[illegible] in *Physica*, **20**, 131–2 (*Feb.*, 1954).

Reports measurements of the susceptibility betwe[illegible] 2°K and the melting point. Discontinuous chan[illegible] occur at 24° and 43°K, corresponding to disc[illegible] tinuous changes of the slope of the specific heat cu[illegible] at these temperatures. E. P. WOHLFAR[illegible]

538.[illegible]

6732. The magnetic properties of trivalent rheniu[illegible] N. PERAKIS. Letter in *J. Phys. Radium*, **15**, [illegible] (*March*, 1954) *In French.*

Describes results of low-temp. susceptibil[illegible] measurements on $ReBr_3$. An unstable compou[illegible] was found to have a variable paramagnetism, [illegible] the stable compound, formed on exposure to air, [illegible] be diamagnetic. Comparison is made with the resu[illegible] for other Re compounds. E. P. WOHLFAR[illegible]

538.2[illegible]

6733. Nuclear induction with separate regions [illegible] excitation and detection. C. SHERMAN. Letter [illegible] *Phys. Rev.*, **93**, 1429 (*March* 15, 1954).

A nuclear induction system in which water flo[illegible] from the exciter to a detecting system $\frac{1}{4}$ in. aw[illegible] and a nuclear resonance signal 50 db above noise [illegible] obtained at the fastest flow rate. D. H. WHIFF[illegible]

538.2[illegible]

6734. Paramagnetic resonance of copper compl[illegible] salts. T. OKAMURA AND M. DATE. *Phys. Rev.*, 9[illegible] 314–15 (*April* 15, 1954).

A paramagnetic resonance experiment was pe[illegible] formed on $Cu(NH_3)_4SO_4.H_2O$ and $Cu(NH_3)_4(NO_3)$[illegible] The character of the $Cu(NH_3)_4^{++}$ group was analyse[illegible] and it was found that the g values of this group a[illegible] small compared with that of the $Cu(H_2O)_4^{++}$ grou[illegible] This can be explained by two methods, one of whic[illegible] is the covalent bonding hypothesis, the other bein[illegible] the usual ionic hypothesis. The exchange interactio[illegible] of these salts is very large, which is considered to b[illegible] the result of covalent bonding structure.

538.22[illegible]

6735. Magnetic susceptibility of carbons and poly[illegible] crystalline graphites. I. H. T. PINNICK. *Phys. Rev.*, **94**, 319–26 (*April* 15, 1954).

In this investigation, the relation of susceptibilit[illegible] to the a dimension of crystallites was studied over th[illegible] range from turbostratic carbons with diameters o[illegible] 50 angstroms, to graphitic crystals with diameters o[illegible]

least several thousand angstroms. Two series of bons, one Thermax carbon black in powder form, other National Carbon baked rods, were prepared which the crystallite size was varied by heat treatnt to different temperatures. A third series conging of carbon blacks with different particle sizes m 50 Å to 3000 Å was prepared by heating to 00°C, the particle size limiting the crystallite growth. e crystallite diameter was determined from the oadening of the X-ray diffraction lines, 10 (twonensional asymmetric diffraction line) and 110. e magnetic susceptibility was measured at room nperature by the Gouy method, and the measureents were made with fields ranging from 2000 to 500 oersteds to correct for ferromagnetic impurities. e mass susceptibilities of all carbons plotted against ystallite diameter fall within a narrow band showing at the susceptibility is primarily a function of ystallite size. Almost all the increase in susceptility from $-0{\cdot}5\times10^{-6}$/g for very small crystallites romatic molecules) to $-7{\cdot}8\times10^{-6}$/g for large ystals takes place in the range of diameters from Å to 150 Å. The sharp increase in susceptibility is scussed in relation to the changes in the Hall effect d thermoelectric power as a function of heat eatment. It is concluded that this increase is due to n increase in the filling of the π band which brings e Fermi level into a region of higher curvature of e constant-energy surfaces. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

6736. On the attraction between a perfectly conducting plate and a thin perfectly conducting cylinder. H. G. VAN BUEREN. *Proc. K. Ned. Akad. Wetensch. B*, 5, 493–9 (1952).

Calculation, using first-order electrodynamic perurbation theory, of the interaction energy between a ery thin cylindrical wire and a plate, in the limit of arge distances. Although the interaction is larger han that between a particle and a plate it is still oo small to be measurable. The change of the esonant frequencies of a cavity when a thin wire is ntroduced is derived in the course of the computation. M. R. HOPKINS

538.3

6737. The electromagnetic field in moving anisotropic nedia. G. MARX. *Acta phys. Hungar.*, **3**, *No.* 2, 75–94 (1953) *In German.*

Field equations are written in covariant form and an expression is obtained for the Lagrange function. Possible forms for the energy-momentum tensor are considered. R. A. NEWING

538.3

6738. Metric and units in electrodynamics. H. SCHILT. *Helv. phys. Acta*, **27**, *No.* 1, 67–70 (1954) *In German.*

The electromagnetic equations are written as $\phi_{lk,l}+\phi_{li,k}+\phi_{kl,i}=0$, $H^{ik}{}_{,i}=\Pi s^k$ with $H^{ik}=\Lambda g^{\frac{1}{2}}g^{il}g^{km}\phi_{lm}$. The values of the constants Π and Λ are noted for various systems of units. R. A. NEWING

538.3

6739. Displacement current, a useless concept. F. W. WARBURTON. *Amer. J. Phys.*, **22**, 299–305 (*May*, 1954).

The Maxwell relation, $\mathrm{curl}\mathbf{B}=(\mu k/c)\partial\mathbf{E}/\partial t+4\pi\mu\mathbf{j}$, is obtained directly by differentiation without mention of displacement current. It is also deduced as a consequence of propagation with speed c, and the form of the expressions chosen for the fields **E** and **H**. These methods of examining retarded action of charge on charge have the advantage over emphasis on continuous fields that weaknesses of classical theory become evident, and closer correlation with symmetric propagation theories becomes possible. A.

538.3 : 523.877 : 532.51

Some instabilities of a completely ionized plasma. *See Abstr.* 6324

538.522 : 621.3.014.1

6740. On the current induced in a conducting ribbon by a current filament parallel to it. E. B. MOULLIN. *Proc. Instn Elect. Engrs IV*, **101**, 7–17 (*Feb.*, 1954).

For abstract, see Abstr. 7799 (1953).

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 535.31

Stepwise transition from wave optics to ray optics in inhomogeneous anisotropic absorbing media. *See Abstr.* 6455

538.561 : 537.525.6

The dispersion relation of plasma oscillations in an external electric field. *See Abstr.* 6647

538.561 : 621.385.1.029.6 : 621.373.1

6741. Millimeter waves from harmonic generators. C. M. JOHNSON, D. M. SLAGER AND D. D. KING. *Rev. sci. Instrum.*, **25**, 213–17 (*March*, 1953).

The process of generating millimeter microwave energy from a crystal multiplier driven by a reflex klystron is discussed. Quantitative data are given on the intensity of the various harmonics down to a wavelength of 1·9 mm. A harmonic generator of novel construction which has proved superior to the previously used types is described, and details of a built-in crystal detector are given. A.

538.565 : 530.145 : 621.373.42

6742. Quantum theory of a damped electrical oscillator and noise. II. The radiation resistance. J. WEBER. *Phys. Rev.*, **94**, 211–15 (*April* 15, 1954).

For previous part, see Abstr. 6460 (1953). The previous results are extended to include damping and noise due to a radiation resistance. The average electromagnetic field energy of an oscillator of natural frequency ω, with inductance L, coupled to a radiation resistance R, as a function of time t is given by

$$U=\left[\tfrac{1}{2}\hbar\omega+\frac{\hbar\omega}{\exp(\hbar\omega/kT)-1}\right]\{1-\exp[-(R/L)t]\}+U_0\exp[-(R/L)t].$$

Using first-order perturbation theory and quantum statistics, an expression is derived for the radiation

resistance of a circuit. This agrees exactly with the classical value. For an oscillator damped by a radiation resistance the vacuum fluctuation noise, and available noise power are shown to be the same as for an oscillator damped by a lumped resistance. All of the previous results are shown to be applicable to cavity resonators. A.

538.565 : 621.373.42

6743. Vacuum fluctuation noise. J. WEBER. *Phys. Rev.*, **94**, 215–17 (*April* 15, 1954).

An electron stream interacting with a damped oscillator is considered. The vacuum fluctuations and the thermal fluctuations can be observed in the noise. It is shown that an electron stream provides a means for precisely measuring the mean squared electromotive force for certain modes. A.

538.566 : 535.42

Variational principles in the mathematical theory of diffraction. *See Abstr.* 6532

538.566.2

6744. On the additional field produced by propagation in the system earth-air-ionosphere of long electric waves with two examples (horizontal and perpendicular dipoles). W. O. SCHUMANN. *Z. angew. Phys.*, **6**, *No.* 1, 35–43 (1954) *In German.*

A theoretical treatment in which the earth and the ionosphere are treated as poor conductors for wavelengths greater than 3 km. It is shown that the system has a series of eigenvalues and that waves propagated in this way are heavily attenuated.

J. M. HOUGH

538.566.3

6745. On the theory of plasmas in the presence of a constant magnetic field of any intensity superposed on an oscillating electric field. R. JANCEL AND T. KAHAN. *C.R. Acad. Sci.* [*Paris*] **238**, 995–6 (*March* 1, 1954) *In French.*

Generalization of former results [Abstr. 5594 (1953)] showing that these remain approximately valid for the case of a magnetic field of any intensity and orientation.

G. M. BROWN

538.566.3 : 621.396.11

6746. Ionospheric absorption at vertical and oblique incidence. G. MCK. ALLCOCK. *Instn Elect. Engrs Paper* 1664, 8 *pp.* [To be published also in *Proc. Instn Elect. Engrs*].

Measurements of the ionospheric absorption of radio waves of frequency 9·15 Mc/s over an 800 km path, and of frequency 5·455 Mc/s at vertical incidence at the mid-point of this path, have been made simultaneously over a period of 14 months. A discrepancy between the observed results and those predicted by Martyn's absorption theorem is found, which varies diurnally. The oblique-incidence results are examined in detail, and empirical formulae for diurnal and seasonal variation of absorption are derived. A.

538.566.3 : 621.396.11

6747. Ray-path characteristics in the ionosphere. G. MILLINGTON. *Instn Elect. Engrs Monogr. No.* 94, 15 *pp.* (*April* 15, 1954) [To be republished in *Proc. Instn Elect. Engrs IV*].

The paper is based on an earlier one by the author [*Instn Elect. Engrs Monogr. No.* 1, 14 *pp.* (*April* 1 1951); Abstr. 2371 B (1951)] and presents an improv method of making magneto-ionic calculations that both quicker and more accurate than the graphic construction previously given. By means of a ne parameter the symmetrical cases can be studied in simple manner and the asymmetry in the general ca can be more readily examined. Propagation in t magnetic meridian plane is discussed in detail, i cluding the phenomenon described by Poeverlein a cusp at the apex to the ray path within a certa critical angle of incidence. The problem of directio finding errors at short distances due to the late deviation caused by the earth's magnetic field treated as a perturbation of the vertical inciden case, and it is shown that the effect is likely to large only under critical conditions that it would difficult to obtain in practice. A short discussion given of absorption, with special reference to t effect of the earth's magnetic field on non-deviati absorption.

538.566.3 : 551.594

6748. The scattering of electromagnetic waves b turbulent atmospheric fluctuations. F. VILLARS AN V. F. WEISSKOPF. *Phys. Rev.*, **94**, 232–40 (*April* 1 1954).

The statistical theory of turbulence is applied to th problem of density fluctuations in the troposphe and the ionosphere. For suitable wavelengths, fo which the so-called similarity region (Kolmogoro spectrum) of the spectrum of turbulence is relevan a closed formula can be given for the scattering cros section. It contains as only parameter the turbulen power dissipation S, and its angular dependence given by $(\sin \frac{1}{2}\theta)^{13/3}$, θ being the scattering angle. Th values of S required to explain ionospheric scatterin are in excellent agreement with values found fro investigations of meteor trails. Tropospheric dat cannot be fitted with the assumptions of dry-a turbulence alone. The inference is that humidit fluctuations play an essential part in tropospheri scattering. A preliminary study of these latte fluctuations gives satisfactory results. Further invest gations (and experimental data) are needed, however to work out a quantitative theory. A

MAGNETIC EFFECTS 538.6

538.6

6749. Relations between the magneto-optical pheno mena in the visible and Hertzian regions. A. KASTLER *C.R. Acad. Sci.* [*Paris*] **238**, 1007–9 (*March* 1, 1954 *In French.*

It is shown that the transverse non-reciproca magneto-optic effect observed with Hertzian waves i related to the equatorial Kerr effect predicted b Wind and observed by Zeeman. P. M. DAVIDSON

538.614

6750. Rotation of the microwave polarization i liquid crystals. G. A. MANN AND R. D. SPENCE Letter in *J. appl. Phys.*, **25**, 271–2 (*Feb.*, 1954).

Observation is made of the rotation of the plane o polarization of microwaves by liquid crystals o

...izoxyanisole in a static magnetic field up to ...00 gauss. This is explained as a consequence of ...e known difference of ε'' with the measuring field || ...d $\perp$ to the magnetic field. D. H. WHIFFEN

538.614 : 548.7

...51. The Faraday effect of coloured rocksalts. ... UCHIDA AND K. FUKUDA. *Mem. Coll. Sci. Univ. ...oto A*, **26**, 63–8 (*Oct.*, 1950).

From magneto-rotary power measurement on ...loured NaCl it is found that the Verdet constant is ...oportional to the density of *F*-centres. Variation ...th wavelength shows that below 420 mμ the con...ant is positive but becomes negative at longer ...avelengths with a maximum at 490 mμ.

G. F. J. GARLICK

538.63 : 537.312.5

...752. Magneto-resistance of Cs_3Sb photocathodes. ... SAKATA AND S. MUNESUE. *J. Phys. Soc. Japan*, **9**, ...41–2 (*Jan.–Feb.*, 1954).

From measurements of magneto-resistance at ...arious temperatures the mobility of holes in ...s_3Sb photocathodes is measured. Values between ...22 cm sec^{-1} volt^{-1} cm^{-1} at 216°K and 412 cm sec^{-1} ...olt^{-1} cm^{-1} at 364°K are obtained. G. F. J. GARLICK

538.632

...753. Measurement of the Hall coefficient of α- and ...-brass. O. G. JEPPESEN. Letter in *Nature* [*London*] ...**73**, 591–2 (*March* 27, 1954).

Reports results of room-temperature measurements ...f the Hall coefficient of rectangular brass strips with ...eight concentrations of copper between 100% and ...0%. The sign of the coefficient remains negative ...ver the whole range which includes the transforma...ion from α- to β-brass. The absence of a sign change ...uring the transformation is in opposition to ...eoretical predictions. E. P. WOHLFARTH

538.632 : 539.11

...754. The Hall constant of graphite. D. F. ...OHNSTON. Letter in *Phys. Rev.*, **93**, 1420 (*March* 15, ...954).

Calculations of the electronic energies of the con...uction states of graphite have been extended to a ...hree-dimensional model. The method is based on ...he "tight-binding" principle and takes account of the ...overlap" of many neighbours. From these electronic ...nergies the Hall constant of graphite has been ...alculated as a function of temperature and the ...umber of "trapping" states. The values obtained ...re compared with experimental observations.

A. E. DE BARR

538.632 : 548.7

...755. Electronic Hall effect in diamond. A. G. ...EDFIELD. *Phys. Rev.*, **94**, 526–37 (*May* 1, 1954).

A method for measuring the Hall mobility in ...nsulating photoconductors is described which avoids ...he space-charge difficulties present in previous ...measurements. Unconventional electrodes are used, ...nd the method differs from the conventional one in ...everal other ways. It is a transient method, and ...he electric field in the sample is rotated by the ...xternal electrodes, rather than by the electrons under ...tudy. The direction of charge flow is deduced from ...a current measurement, rather than by confining the ...urrent to a thin sample whose orientation gives the direction of charge flow. No attempt is made to inject or eject electrons through the surface of the sample. Measurements using this technique have been made on a number of diamonds. Both electrons and holes are found to contribute to the photoconductivity, making interpretation of the data difficult. It is tentatively concluded that the electronic mobility varies as $T^{-\frac{3}{2}}$ and is about 1800 cm^2/volt sec at 300°K. For holes it is concluded (with far less certainty) that the mobility also varies as $T^{-\frac{3}{2}}$ and is somewhat greater than 1200 cm^2/volt sec at 300°K. These observations are consistent with the deformation potential theory of electronic mobility in non-polar crystals. A.

538.632 : 548.7

6756. Electronic Hall effect in the alkali halides. A. G. REDFIELD. *Phys. Rev.*, **94**, 537–40 (*May* 1, 1954).

The Hall mobility of electrons in coloured NaCl, KCl, KBr and KI has been measured using an unconventional technique (see preceding abstract). Measurements on additively and X-ray coloured NaCl yield an electronic mobility of 250 $\pm$ 50 cm^2/volt sec at 84°K, decreasing to about 25 $\pm$ 25 at 200°K. In additively coloured KCl the mobility is 100 $\pm$ 50 at 90°K; in additively coloured KBr it is about 110 at 84°K. In additively coloured KI the mobility is 155 $\pm$ 30 at 84°K, decreasing to 30 $\pm$ 15 at 200°K. In every case the sign of the Hall effect is electronic. These observations are consistent with the mobility theory of Low and Pines assuming effective mass ratios between 0·35 and 0·6 for the unpolarizable crystal, or polaron effective mass ratios between 0·5 and 0·9. These mobility data combined with photoconductive yield data give values of the capture cross-section of *F*-centres for electrons (to form *F'*-centres) between 0·7 and 5 times 10^{-15} cm^2 at about 200°K. A.

538.652

6757. Volume magnetostriction in nickel and the Bethe–Slater interaction curve. K. AZUMI AND J. E. GOLDMAN. Letter in *Phys. Rev.*, **93**, 630–1 (*Feb.* 1, 1954).

Reports resistance strain gauge measurements of $\omega = \Delta V/V$ as a function of applied field strength (up to 6000 oersted), obtaining $(\partial\omega/\partial H)_T = -0{\cdot}55 \times 10^{-10}$. This result is discussed with reference to thermodynamic relations between magnetic quantities and the curve giving the dependence of the interchange interaction on atomic separation. E. P. WOHLFARTH

538.653 : 538.245

6758. Behavior of ferromagnetic domains under stress. G. BONFIGLIOLI, A. FERRO, G. MONTALENTI AND G. ROSA. *Phys. Rev.*, **94**, 316–18 (*April* 15, 1954).

The results of some experiments referring to the analogy between the effects of *H* (uniform magnetic field) and σ (static mechanical stress) on the motion of Weiss domains are described. Together with the results of previous work, the present paper attempts to show the existence of a magnetoelastic Barkhausen effect. A special extensometer with a strain sensitivity of 10^{-7} and completely free from hysteresis was used. Experiments have also been carried out on

electrical resistivity variation. The results are summarized as follows: the curves of the remanent strain, $\varepsilon_r = (\Delta l/l)_r$ *v.* σ_{max}, and of the remanent electrical resistivity variation, $(\Delta\rho/\rho)_r$ *v.* σ_{max}, traced for two Ni specimens, one as cast and one annealed, show the same behaviour as J_r (remanence magnetization) *v.* H_{max}. Both remanent strain and remanent electrical resistivity variation can be reduced to zero by demagnetizing the specimen. By means of these experiments the characteristic points of the magneto-mechanical hysteresis loop have been determined statically and compared with the magnetic case. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

6759. On the state of solid hydrogen. K. Tomita and I. Mannari. Letter in *Progr. theor. Phys.*, **10**, 367–9 (*Sept.*, 1953).

Analyses the proton resonance data obtained by Hatton and Rollin [Abstr. 427 (1950)] to throw light on Schafer's theory of the specific heat anomaly of solid hydrogen below 10°K [*Z. phys. Chem.*, **42**, 380 (1939)]. E. P. WOHLFARTH

539.11

6760. On the radiative interaction of phonon field with electrons. H. Kanazawa. Letter in *Progr. theor. Phys.*, **10**, 471–2 (*Oct.*, 1953).

Calculation of the level width and shift, the latter being found identical with the electron energies according to Fröhlich. W. A. HEPNER

539.11

6761. On the atom-exciton interaction. T. Ohta. Letter in *Progr. theor. Phys.*, **10**, 474 (*Oct.*, 1953).

The interaction potential between an exciton, considered as a rotating dipole, and the nearest neighbour atom is considered and shown to be weakly attractive of the van der Waals type with short-range effect. G. F. J. GARLICK

539.11

6762. Thermal and mechanical behaviour of amorphous solids as a result of molecular transposition. W. Holzmüller. *Z. phys. Chem.*, **202**, 440–59 (*Jan.*, 1954) *In German.*

Beginning with the supposition of independent heat waves (analogous to the elastic heat waves of Debye) to which Boltzmann statistics are applicable the probability of transposition of neighbouring particles in solids is calculated. The method contributes to the understanding of melting in crystals, softening in amorphous solids, the relatively good thermal conductivity of crystals while that of glasses and resins is poor, the small temperature dependence of tensile strength and of plastic flow in crystals, the relatively small temperature dependence of elastic properties and of dielectric loss in crystals containing impurities, and the large temperature dependence of dielectric loss in glasses. W. GOOD

539.

6763. The structure of the solution of the many electron problem in solids and a theorem of Bloch. H. Haken. *Z. Naturforsch.*, **9a**, 228–35 (*March* 1954) *In German.*

Gives a very general treatment of the solution of the wave equation for a system of electrons in solids. Interelectronic interaction terms depending on relative distance, velocity and spin, as well as terms describing the interaction between electrons and lattice vibrations, are included in the Hamiltonian operator. The form of the wavefunction in the general case is derived. An expression for the current density is obtained and shown to reduce to the standard form. A theorem due to Bloch, that the lowest electronic state is non-conducting, is re-derived.

E. P. WOHLFAR

539.

6764. Studies on localized orbitals. H. Winsto *Phys. Rev.*, **74**, 328–36 (*April* 15, 1954).

Wannier functions for free electrons in one dimension are discussed in some detail. The effects of the choice of lattice points and unit cell size are discussed and details of the symmetry properties of the one-dimensional nearly-free-electron wavefunctions are given. The general relation between symmetry in the local site and three-dimensional space group symmetry is given. The possibilities for localized orbital treatment of metals and perturbed lattices are considered, and the electronic structure of CdSb is examined in terms of localized orbitals. The term *site orbital* is proposed to include the special cases of Wannier functions and Lennard-Jones equivalent orbitals.

539.

6765. Valence bond calculations. L. A. Schm *Amer. J. Phys.*, **22**, 255–63 (*May*, 1954).

The nature of the binding in molecular and ionic crystals and in metals is briefly discussed from an intuitive point of view. The salient features of the Slater–Pauling theory of the valence bond are then developed by generalizing the results of the Heitler–London treatment of the hydrogen molecule. The application of the theory to the calculation of the cohesive energy of diamond, the classic example of a valence crystal, is then discussed.

539.11 : 535.343.2–

Microwave spectrum and structure of solids. S *Abstr.* 6484

539.11 : 535.343.2–15 : 538.6

6766. Electronic structure, infrared absorption, and Hall effect in tellurium. H. B. Callen. *J. che Phys.*, **22**, 518–22 (*March*, 1954).

An analysis of the band structure of tellurium based on the symmetry properties of a drastically simplified model of its crystal structure. The symmetry considerations lead to suggestions of the physical mechanisms underlying a variety of experimental facts in this material.

539.11 : 548

6767. Exchange energy of electrons in metals and ionic crystals. J. R. Reitz. *J. chem. Phys.*, 2 595–8 (*April*, 1954).

The exchange energy of valence electrons in bo

onatomic and diatomic crystals is computed in the och approximation for the case where the lowest ectronic wavefunction in the band shows consider- le spatial variation. Only ground-state wave- nctions which are spherically symmetric in each omic cell are considered, but within this limitation o types of spatial variation are considered: radial riation in the unit cell, and the variation in a atomic lattice due to the wavefunction being more ncentrated on one of the atomic species than on e other. The results of the calculation show that, r a monatomic solid, deviations from uniformity the wavefunction have a relatively small effect on e exchange energy; in highly ionic diatomic solids, owever, the exchange energy may be increased up 50% in magnitude over the free-electron value as a sult of the electron density in anion cells being fferent from that of cation cells. A.

539.11 : 548.7 : 535.343.2–14/15

Study of crystal defects in solids with the aid of icrowave absorption. *See Abstr.* 6483

MOLECULAR STRUCTURE 539.13

539.13

768. Physical interaction of carcinogenic substances ith chain molecules. T. NEUGEBAUER. *Acta phys. lungar.*, **2**, *No.* 4, 345–7 (1952) *In German.*

A mathematical investigation leads to the con- lusion that, on account of the very high diamagnetic usceptibilities of aromatic carcinogens perpendicular o the plane of the rings, such molecules can enter nto strong van der Waals interactions with chain olecules (e.g. polypeptides). C. B. ALLSOPP

539.13

769. Inelastic collisions between two molecules. . INOUE AND T. TAKAHASHI. *J. Phys. Soc. Japan*, , 199–203 (*March–April*, 1954).

The collision between two diatomic molecules is reated quantum-mechanically. Group theoretical rguments are used, and the differential equations for he internal wavefunctions are derived. The pro- edure is due originally to Curtiss and Adler, but is nore direct and suitable for collision problems. The quations are solved by Zener's method, and transi- ion probabilities are obtained in terms of integrals f interaction potential and a set of phase shifts. It s also shown that the collision between two poly- tomic molecules can be treated in a similar way. A.

539.132

770. On the electronic structure of LiH; atomic rbital approach with configurational interaction. K. TOMITA AND K. FUKUI. Letter in *Progr. theor. Phys.*, **10**, 362–3 (*Sept.*, 1953).

The ground state was calculated with inclusion of ll electrons. Configuration interaction was applied o the six lowest configurations. The binding energy was found to be 0·0725 a.u., which is 75% of the bserved value. The first three configurations are most important for the decrease in energy with espect to that of one configuration. These involve *s–p* hybridization and the ionic structure Li^+H^-. The fundamental frequency $1{\cdot}13\times10^3\ cm^{-1}$ is somewhat smaller than the observed value. The valence-shell treatment was also applied, but this was found to be less reliable. A. J. TAYLOR

539.132

6771. On the delocalization energy in molecules. K. NUKASAWA. Note in *J. Phys. Soc. Japan*, **9**, 133–4 (*Jan.–Feb.*, 1954).

An attempt to calculate these energies by applying the perturbation method to Roothaan's equation. Good agreement with previous results is obtained for 1,3 butadiene; it is less good for benzene, where the delocalization energy is too large for the method to be valid. J. JACOBS

539.132

6772. Maxima in the potential energy–distance functions of diatomic molecules. R. F. BARROW. Letter in *J. chem. Phys.*, **22**, 573 (*March*, 1954).

Several cases where maxima appear to exist are noted: they may be less unusual than has been considered hitherto. R. F. BARROW

539.132

6773. Simultaneous excitation and dissociation of water molecule by hydrogen canal ray impact. T. HORIE AND M. OTSUKA. *J. Phys. Soc. Japan*, **9**, 219–24 (*March–April*, 1954).

By electron impact, a water molecule dissociates into an OH radical in the excited state and a H atom in the ground state. Immediately after the dissociation, the excited radical makes a transition into the ground state, emitting the intensive (0, 0)-band of OH. According to the studies on intensity measurement of the rotational lines of the band, it has so far been shown that the excited radicals have an exceedingly abnormal distribution of rotational energy. Any sufficient interpretation of this phenomenon, however, has not yet been given from a theoretical standpoint. The measurement of the rotational intensity distribution of the fragment molecule OH dissociated from the water molecule by hydrogen canal ray impact was undertaken as a contribution to this problem. According to the experiment, it does now show so much abnormality as in the case of electron impact, but to some extent fades into a normal Maxwellian distribution. A.

539.132 : 535.33

6774. The energy of dissociation of BeO. A. LAGERQVIST. *Ark. Fys.*, **7**, *Paper* 39, 473 (1954).

If the state $A^1\Pi$ dissociates to give $Be(^1S) + O(^1D)$, the spectroscopic value for the dissociation energy becomes 4·8 eV, in fair agreement with thermochemical estimates. R. F. BARROW

539.132 : 535.338.4

The λ 4050 bands of the C_3^{13} molecule. *See Abstr.* 6473

539.132

6775. Rotation-vibration spectra and structure of the allene molecule. R. C. LORD. Letter in *J. Opt. Soc. Amer.*, **44**, 256 (*March*, 1954).

The small variations in the value of the rotational constant I_B of the allene molecule, suggested by Overend and Thompson [Abstr. 265 (1954)], do not

change the value of I_A from that of $5{\cdot}28\ cm^{-1}$ determined by Lord and Venkateswarlu [Abstr. 8054 (1952)]. G. I. W. LLEWELYN

539.132

6776. Transition probabilities in band systems of diatomic molecules. G. LUKACS. *J. Phys. Radium*, **15**, 161–4 (*March*, 1954) *In French.*

Discussion of the "distortion" method of obtaining approximate vibrational wavefunctions for a Morse potential from those of the harmonic oscillator [Abstr. 9631 (1951)]. The effect on the wavefunctions of different expressions for the displacement of the "centre" of the wave-function from $r = r_e$, is examined for high and low energy levels. J. HAWGOOD

539.132

6777. Anharmonicity and the calculation of a quadratic potential function for molecular vibrations. C. MANNEBACK AND A. RAHMAN. *J. Phys. Radium*, **15**, 204–5 (*March*, 1954) *In French.*

As experimental values found for frequencies are often inaccurate, the error in parameters estimated with these values, which are necessary for the calculation of the potential vibration function for a molecule and its isotopes, may be large. Another cause of error is that the amplitude of the vibration is not infinitely small, so that anharmonicity effects should be taken into account. These effects are investigated and several examples discussed. It is found that in some cases a quadratic function is meaningless and that higher terms should be included. A. J. TAYLOR

539.132

6778. Analysis of the bands (4, 0) (5, 1) and (6, 2) of the vibration-rotation system of OH. G. DÉJARDIN, J. JANIN AND M. PEYRON. *J. Phys. Radium*, **15**, 222 (*March*, 1954) *In French.*

These bands are measured, and a relation is derived which represents the vibration-rotation values found here and previously. The constants occurring in the relation, which takes account of the doublet, are calculated. A. J. TAYLOR

539.132 : 536.7

6779. The vibrational assignment and thermodynamic properties of *n*-dimethylaminodiborane. D. E. MANN. Letter in *J. chem. Phys.*, **22**, 762 (*April*, 1954).

Some changes from the earlier paper [Abstr. 3298 (1954)] have been made in assignment, because of new data. A table is given of the thermodynamic functions for the ideal gaseous state at 1 atm and a barrier of 3·9 kcal/mole (for agreement with the experimental entropy). C. TURNER

539.132 : 535.375.54

On the effect of the hydrogen bond on Raman spectrum. *See Abstr.* 6516

539.132

6780. Vibrational transition probabilities to high quantum numbers for the nitrogen first and second positive band systems. W. R. JARMAIN AND R. W. NICHOLLS. Note in *Canad. J. Phys.*, **32**, 201–4 (*Feb.*, 1954).

The tables given of the transition probabilities for the first positive ($B^3\Pi_g \rightarrow A^3\Sigma_u^+$) and second positive ($C^3\Pi_u \rightarrow B^3\Pi_g$) band systems of nitrogen have computed by numerical integration of Morse functions. The vibrational quantum numbers both range from 0–12 for the first band; v' goes 0–4, v'' from 0–12 for the second. The mole data used are also tabulated. In the tran integral the electronic transition moment $R_e(r$ been assumed independent of r. The results are given diagrammatically, together with the main subsidiary Condon parabolae. These data proved useful in the interpretation of labor spectra involving large vibrational quantum num A. J. TA

53

6781. Energy levels of triatomic molecules. MAJUMDAR. *Proc. Phys. Soc.* [*London*] *A*, **67**, 3 (*April*, 1954).

The mathematical theory of the asymmetrica and of triatomic molecules has been conside simplified by removing two of the Eulerian a from the wave equation by a special artifice. As totic expressions for the eigenvalues of the forme the centrifugal and Coriolis corrections to be ap to the energy levels of the latter have been obt in closed forms for values of J exceeding 9 wi solving any secular equation.

53

6782. Magnetic properties of the hydrogen mole E. ISHIGURO AND S. KOIDE. *Phys. Rev.*, **94**, 3 (*April* 15, 1954).

The diamagnetic susceptibility χ, the rotat magnetic moment μ_r, the magnetic shielding con σ, and the spin-rotational magnetic intera constant H_r of the hydrogen molecule are calcu theoretically. The energy of the rotating mole under an external magnetic field, is calculate means of the variational method using $7 + 2$ wavefunction. By expanding the energy in po of the appropriate parameters, χ, μ_r, σ and H determined and the relations between these quan are obtained. Comparison with Ramsey's ex ments is also made.

539

6783. Theory of the hyperfine structure of molecule. M. MIZUSHIMA. *Phys. Rev.*, **94**, 56 (*May* 1, 1954).

The theory of the h.f.s. of the NO molecule d the magnetic moment and the electric quadru moment of the N nucleus is worked out. Assu that the electron which is rotating around the m cular axis is in a pure p state, some relations bet coupling constants are derived and were foun agree with experimental relations. Hund's cas was taken as a starting point, but the actual devi from case (a) was found to be not negligible and also explained satisfactorily. The formula for nuclear electric quadrupole effect was derived Hund's case (a) and also for a general coupling This electric quadrupole effect was found t different for Λ-type doublet states. The differ appears for every coupling case including Hu case (a). The agreement between theory and ex mental results is quite satisfactory.

539.132

4. Spin relaxation in free radical solutions biting hyperfine structure. J. P. Lloyd and E. Pake. *Phys. Rev.*, **94**, 579–91 (*May* 1, 1954).

Experimental studies of spin-lattice relaxation in ueous solutions of the free-radical peroxylamine sulphonate ion, $ON(SO_3)_2^{--}$, have been made in lds near 30 oersteds. The continuous wave turation technique was used to study the transition $= \frac{3}{2}$, $m_F = -\frac{3}{2} \rightarrow F = \frac{3}{2}$, $m_F = -\frac{1}{2}$, for which e frequency was 60 Mc/s. Because the hyperfine teraction of the unpaired electron with the N^{14} ucleus leads to six unequally spaced energy levels, unique relaxation time cannot be defined. A neral treatment of the saturation method leads to finition of the relaxation probability, which reduces r a system with two energy levels tc the reciprocal of vice the relaxation time. The experimentally easured relaxation probability is found to be con-ntration independent below 0·005 molar in $N(SO_3)_2^{--}$, approaching an asymptotic value of $\times 10^6$ sec^{-1}. Experiment and theory both rule out s the source for this relaxation probability the teraction of the electron moment with the nuclear oments of the H_2O solvent molecules, and theory lso rules out the effect of the N^{14} electric quadrupole oupling to solvent motions; the latter can, in rinciple, effect electron relaxation because of the yperfine coupling between the N^{14} nuclear spin and ne electron spin. Estimates are made of the rôle layed by spin-orbit coupling, and it appears probably nat the observed relaxation involves this interaction. n interesting by-product of the analysis of the elaxation probability is the result that second-order tatistical processes, by which an electron spin is first ed with energy conservation to an excited Stark before reaching the ground Stark level of pposite spin, may account for the observed relaxa-ion. This process is somewhat similar to the Raman rocesses invoked by Van Vleck to explain relaxation n the alums, except that in Van Vleck's theory the ntermediate excited Stark level is only virtually ccupied, without energy conservation. A.

539.132 : 535.343–14

Microwave resonance in nitric oxide: lambda oubling and hyperfine structure. *See Abstr.* 6477

539.132 : 539.152.2

6785. Transient nuclear induction signals associated with pure quadrupole interactions. M. Bloom and R. E. Norberg. Letter in *Phys. Rev.*, **93**, 638–9 (*Feb.* 1, 1954).

The decay of pure quadrupole induction signals has been observed following the application to $NaClO_3$ of r.f. pulses of the quadrupole resonance frequency. With a Zeeman field of 12 gauss along (0, 0, 1) and || to the r.f. field, a periodic structure is developed. Theoretical expressions are obtained as solutions to the time-dependent Schrödinger equation which show the observed dependency of the periodic frequency with crystal orientation and the Zeeman field.

D. H. WHIFFEN

539.132 : 539.152.2

6786. The electric quadrupole splitting of the nuclear magnetic resonance lines of sodium in a single crystal of $Na_2S_2O_3 . 5H_2O$. J. Itoh, R. Kusaka and Y. Yamagata. *J. Phys. Soc. Japan*, **9**, 209–18 (*March–April*, 1954).

Splitting of the nuclear magnetic resonance lines of sodium due to the nuclear electric quadruple interaction was measured in a single crystal of sodium thiosulphate pentahydrate. Since each molecule contains two sodium nuclei which have different electric quadrupole interactions, and there are two groups of molecules with different orientations in a unit cell, twelve lines were observed in general. The experimental results were compared with the theoretical calculation of Bersohn and the values of e^2qQ, η and the directions of the principal axes of the field-gradient tensor were determined for each nucleus. The values of e^2qQ and η are 2·26 Mc/s and 0·334, and 0·830 Mc/s and 0·41 respectively for two nuclei in the molecule. A.

539.132 : 539.152.2

6787. Proton magnetic resonance in an ammonium chloride single crystal. R. Bersohn and H. S. Gutowsky. *J. chem. Phys.*, **22**, 651–8 (*April*, 1954).

The nuclear resonance absorption spectrum has been calculated theoretically for a tetrahedral 4-spin system, with I of $\frac{1}{2}$, for orientations in which the external magnetic field coincides with a two- or three-fold symmetry axis of the tetrahedron or with a tetrahedral edge. Comparison of the theoretical results with the proton resonance observed at −195°c in a single crystal of ammonium chloride demonstrates that the NH_4^+ ion is oriented with the N — H bonds pointed essentially towards corners of the unit cube. An N — H distance of 1·032 ± 0·005 Å is determined from the low-temperature second moments of the resonance line with the applied magnetic field in the (1, 0, 0) and (1, 1, 0) directions. At room temperature, the anisotropy of the resonance results from inter-NH_4^+ interactions, with intra-NH_4^+ interactions averaged to zero by hindered rotational motions; free rotation of the ammonium ions does not occur. A small decrease with temperature of the second moment of the resonance line at the λ-point agrees with the order-disorder model for the transition. The motion of the NH_4^+ ion is discussed. A.

539.132 : 539.152.2

6788. Effects of diffusion on free precession in nuclear magnetic resonance experiments. H. Y. Carr and E. M. Purcell. *Phys. Rev.*, **94**, 630–8 (*May* 1, 1954).

Nuclear resonance techniques involving free precession are examined, and in particular, a convenient variation of Hahn's spin-echo method is described. This variation employs a combination of pulses of different intensity or duration ("90-degree" and "180-degree" pulses). Measurements of the transverse relaxation time T_2 in fluids are often severely compromised by molecular diffusion. Hahn's analysis of the effect of diffusion is reformulated and extended, and a new scheme for measuring T_2 is described which, as predicted by the extended theory, largely circumvents the diffusion effect. On the other hand, the free precession technique, applied in a different way permits a direct measurement of the

molecular self-diffusion constant in suitable fluids. A measurement of the self-diffusion constant of water at 25°C is described which yields $D = 2{\cdot}5(\pm 0{\cdot}3) \times 10^{-5}$ cm²/sec, in good agreement with previous determinations. An analysis of the effect of convection on free precession is also given. A null method for measuring the longitudinal relaxation time T_1, based on the unequal-pulse technique, is described. A.

539.132

6789. Approximate molecular orbitals. I. The $1s\sigma_g$ and $2p\sigma_u$ states of H_2^+. A. DALGARNO AND G. POOTS. *Proc. Phys. Soc.* [*London*] *A*, **67**, 343–50 (*April*, 1954).

The variational method is used to obtain approximate wavefunctions for the $1s\sigma_g$ and $2p\sigma_g$ states of H_2^+. Their accuracy is assessed by comparing various quantities computed using the approximate wavefunctions with the exact values of these quantities. The dependence of the total kinetic and potential energies on the nuclear separation is briefly discussed. A.

539.132

6790. The valence-bond theory of molecular structure. II. Reformulation of the theory. R. MCWEENY. *Proc. Roy. Soc. A*, **223**, 306–23 (*May* 6, 1954).

The construction of spin eigenfunctions and the evaluation of matrix elements between them are discussed generally in preparation for a development of the valence bond (VB) theory along the lines indicated in Pt I [Abstr. 4816 (1954)]. The customary approximation of considering explicitly only the electrons outside a "closed shell" is shown to be defensible. The reformulation of the VB theory is now straightforward, but its final description of bonding is quite new. Atomic orbitals (AO's) are replaced, whenever they appear, by orthogonalized atomic orbitals ($\overline{\text{AO}}$'s); but when the assumptions of the conventional theory are rigorously validated in this way the "covalent" structures (now "$\overline{\text{VB}}$" structures) are found, quite generally, to indicate only strong repulsion between the "bonded" atoms, and formal descriptions of bonding and of bond orders, in terms of "spin-pairing," become nonsensical. Bonding can be described only by admitting into the wavefunctions polar $\overline{\text{VB}}$ structures; a bond between two atoms demands the appearance (with considerable weight) of pairs of structures differing by a "charge hop" between the atoms concerned. The conventional VB structures are found to be equivalent to certain groupings of $\overline{\text{VB}}$ structures (non-polar and polar) and do, indeed, predict bonds between spin-paired atoms and repulsion between the atoms of different pairs. It is then possible to make full use of chemical intuition, using a plausible combination of conventional structures as a starting approximation in the more rigorous theory. A numerical illustration is provided by a discussion of the Kekulé structures of benzene. Some important characteristics of energy calculations in the $\overline{\text{VB}}$ theory are pointed out. Quantities of intra- and inter-atomic origin are well separated, and the method is apparently well suited to development along either *ab initio* or empirical lines. A.

539.133 : 539.1

6791. Structural investigations by means of nucl magnetism. III. Ammonium halides. H. S. GUTO SKY, G. E. PAKE AND R. BERSOHN. *J. chem. Ph* **22**, 643–50 (*April*, 1954).

For Pt II, see Abstr. 5180 (1950). The pro magnetic resonance absorption has been measure NH_4Cl, NH_4Br and NH_4I crystal powders fr −195°C to room temperature, and for NH_4Cl 200°C. Line width transitions were found at −1 −171 and about −198°C in the chloride, brom and iodide, respectively. The N — H distance in ammonium ion was determined to be $1{\cdot}035 \pm 0{\cdot}0$ from the second moments of the broad, low-tempe ture absorption lines observed in NH_4Cl and NH_4 with allowance for broadening by modulation effe and narrowing by zero-point torsional oscillatio The relatively narrow room temperature line sha are consistent with the broadening estimated for in NH_4^+ interactions, the intra-NH_4^+ interactions aver ing to zero over the hindered rotational motions of NH_4^+ ions. No appreciable line shape changes w found at the λ-temperatures. An electrosta calculation is made of the potential barriers rotation of the NH_4^+ ion giving values compar favourably with experimental inferences. The resu clarify the motions which narrow the absorption l at low temperatures and emphasize the dynam aspects of the order-disorder process.

539.133 : 539.1

6792. The existence of two OH-groups in H_2SO molecules verified by the scattering of thermal neutro J. A. JANIK. *Acta phys. Polon.*, **11**, *No.* 3–4, 33 (1951–52).

The theory of Sachs and Teller [*Phys. Rev.*, 18–27 (*July* 1, 1941)] which states that a neutr which is scattered by a proton bound in a molec may cause this molecule to rotate, can also, w some small alterations, be applied to the scatteri of slow neutrons by some liquids. It gives go agreement for H_2 and H_2O. The experimen absorption coefficient of thermal neutrons in pu H_2SO_4 is $1{\cdot}26\ \text{cm}^{-1}$. This is in good agreement w the value of $1{\cdot}29\ \text{cm}^{-1}$, which was calculated on t assumption that the molecule contained two O groups capable of causing rotation of the molecul A. J. TAYL

539.133 : 548.73

On the inequality of metal-oxygen bond lengths some metal oxides. *See Abstr.* 7038

539.1

6793. Structure of the intermediates in the formati of carbon from organic compounds. Their infrared an ultraviolet spectra. D. HADŽI. *J. Phys. Radium* **15**, 194–6 (*March*, 1954) *In French.*

Pyrogenation products of naphthalene and anthr cene were obtained with the use of $AlCl_3$ in t absence of oxygen. It is suggested that the compound obtained are similar to the intermediates in th formation of carbon by pyrolysis. These compound (asphaltenes) were investigated spectrographically i infrared and ultraviolet. The bands found sugge that the asphaltenes consist of various polycycl systems bound together by single or ethylenic bon or by short aliphatic chains. A. J. TAYL

539.133 : 535.343–15

. Estimation of structural groups in hydro-ons by absorption spectrophotometry in the near fred. E. D. KUNST. *J. Phys. Radium*, **15**, 215–16 *rch*, 1954) *In French.*

Measurements near $3{\cdot}4\mu$ allow estimation of the mbers of CH_3 and CH_2 groups; measurements on harmonic near $1{\cdot}2\mu$ allow this to be done for CH_2, CH-tertiary and CH-aromatic. The thod has been tried on the known structure of ecyl-2-benzene and to determine the structure of opyl-substituted tetralin. G. F. LOTHIAN

ATOMIC STRUCTURE . NUCLEUS. ISOTOPES 539.15

539.152.1

5. Two-nucleon nuclear transitions. L. A. SLIV D L. K. PEKER. *Dokl. Akad. Nauk SSSR*, **92**, . 2, 277–9 (1953) *In Russian.* English translation, S. *National Sci. Found. NSF-tr*-188.

The analysis of nuclear levels into "consecutive" 1 "hole," associated with 2 different types of e-nucleon excitations [Abstr. 7832 (1953)] is ended to nuclei in which both types are present Sb^{85}, Ni^{61}, Y^{91}). Gamma transitions between nsecutive" and "hole" levels are not observed: y would require the simultaneous rearrangement two particles. W. J. SWIATECKI

539.152.1

96. On the *D* state probability of deuteron. MACHIDA. Letter in *Progr. theor. Phys.*, **9**, 683–4 *ne*, 1953).

A restriction on this probability is obtained from e ratio of the hyperfine structure separations of the ound states of deuterium and hydrogen.

G. E. BROWN

539.152.1

97. Evidence for a $(1f^{7/2})^3_{3/2}$ state in $^{49}_{23}V_{26}$. R. H. SSBAUM, A. H. WAPSTRA, G. J. NIJGH, L. T. M. RNSTEIN AND N. F. VERSTER. *Physica*, **20**, 165–8 *farch*, 1954).

Gamma transitions of 63 ± 1 keV ($15 \pm 2\%$), ± 1 keV ($30 \pm 4\%$) and 150 ± 2 keV ($14 \pm 2\%$) tensities relative to total positon activity) were und in the decay of Cr^{49} by means of a single-annel NaI scintillation spectrometer. From γ–γ incidence experiments the 150 keV line is estab-hed to be the crossover transition. Conversion ectrons from the three transitions were found in a agnetic lens type β-ray spectrometer. Conversion efficients were measured from which the assignment f1 (63 keV), *M*1 (89 keV) and *E*2 (150 keV) were rived. A level scheme of V^{49} is proposed, involving e states $7/2^-$, $5/2^-$ and $3/2^-$ from the proton con-guration $(1f_{7/2})^3$, while $5/2^-$ is derived for the ground ate of Cr^{49}. A.

539.152.1

798. On the theory of nuclear evaporation. R. IAGEDORN. *Z. Naturforsch.*, **9a**, 259–61 (*March*, 954) *In German.*

Weisskopf's formula (1937) for the emission probability is rederived in a way which clarifies the rôle of the selection rules. P. T. MATTHEWS

539.152.1

6799. A mixture of central, tensor, and two-particle spin-orbit interactions for N^{14} and D^2. W. J. ROBINSON. *Phys. Rev.*, **93**, 1296–7 (*March* 15, 1954).

The calculations of Elliott on the *p*-shell nuclei Li^6, Li^7 and B^{10} have been extended by the author to the N^{14} nucleus. Only the s^4p^{10} configuration was considered. The central and tensor potentials were taken to be of the Yukawa shape while spin-orbit potentials of both the Yukawa and Case-Pais forms were considered, the ranges being assumed equal. The conclusions are similar to those of Elliott. The object of the deuteron work was to discover whether the conclusions drawn from the *p*-shell calculations were consistent with the deuteron data. Here the potentials were taken to be of the Yukawa form throughout with almost equal ranges. Only one calculation has been carried out, but it indicates that the data required by the *p*-shell nuclei are not inconsistent for the deuteron. A.

539.152.1

6800. The odd-nucleon-plus-liquid-drop-model of heavy odd nuclei. F. J. MILFORD. *Phys. Rev.*, **93**, 1297–1303 (*March* 15, 1954).

The odd-nucleon-plus-liquid-drop-model of the heavy odd nuclei is considered using the techniques developed by Racah in the construction of the nuclear ground states. The odd-nucleon–core interaction is treated perturbation-wise, and the nuclear magnetic moments, quadrupole moments, and the energies of the excited states are investigated. The results are not wholly satisfactory; however, some indications of improvement may be seen. A.

539.152.1

6801. On the proton-neutron interaction. T. KOMODA AND M. SASAKI. Letter in *Progr. theor. Phys.*, **9**, 468 (*April*, 1953).

Results of calculations of magnetic and quadrupole moments of the deuteron are given, using a pseudo-scalar meson potential with a r^{-2} singularity. The results agree well with experimental values in the hard-core approximation. G. FIELD

539.152.1

6802. The binding energy of the alpha particle. A. C. CLARK. *Proc. Phys. Soc.* [*London*] *A*, **67**, 323–30 (*April*, 1954).

The method of Morpurgo [Abstr. 1832 (1953)] is extended to deal with both central and tensor forces, each having Yukawa-type radial dependence. The method is applied to calculate the binding energy of He^4 for one set of Pease–Feshbach force parameters. It is shown that the inclusion of a second *D* state in the trial wave-function leads to a large increase in binding energy. A.

539.152.1

6803. Shell effects in highly excited nuclei. H. W. NEWSON AND R. H. ROHRER. *Phys. Rev.*, **94**, 654–8 (*May* 1, 1954).

The boron absorption method has been used to obtain the following estimates of the energy of the lowest neutron resonance for each of the following

target nuclides: Rb^{85}, 0·97 keV; Rb^{87}, 0·42 keV; Y^{89}, 5·0 keV; La^{139}, 0·08 keV; Pr^{141}, 0·38 keV; and Tl^{205}, 10 keV. The corrections were made in such a way that the figure found is a lower limit for the energy and consequently a lower limit for the order of magnitude of the spacing of *s*-wave resonances. These figures were added to data in the literature, and a plot of *s*-level spacing was made which included most target nuclides of odd mass and odd charge. This curve showed roughly symmetric maxima at the neutron magic numbers 50, 82, and 126. The cases where the compound nucleus contains more neutrons than the magic numbers are qualitatively understandable, since these nuclides are in a low state of excitation compared to normal nuclei in their neighbourhood. An unusually close level spacing, which would be expected on the basis of excitation energy when there are slightly less than a magic number of neutrons, was not observed. It appears (at least near 126 neutrons and 82 protons) that the shell structure is not broken up to any great extent in the compound nucleus. A.

539.152.1 : 539.165.2

6804. Variation of the wave function of the Dirac electron in the interior of the nucleus, when one allows for the extension of the nuclear charge. Algebraic expressions. R. NATAF. *C.R. Acad. Sci.* [*Paris*] **238,** 1012–14 (*March* 1, 1954) *In French.*

A study of the effect of the variation of the radial part of the electron wave-function inside the nucleus in the theory of β-decay. P. T. MATTHEWS

539.152.2

6805. On the spin of the ground state and the first excited levels of certain odd–odd nuclei. C. MARTY, R. NATAF AND J. PRENTKI. *J. Phys. Radium,* **15,** 134–41 (*March*, 1954) *In French.*

The *j–j* coupling model is applied to odd-odd nuclei, and nuclei having one odd nucleon and one hole in a closed shell. A mixture of exchange forces is assumed in proportions determined by the deuteron and saturation conditions. Calculations are made with oscillator wave-functions and δ-function, Yukawa, or constant radial potentials. The ground state is shown to be the same for δ-function and Yukawa potentials and, in particular, the value $J = 4$ is given correctly for K^{40}. The results for RaE^{210} agree with those of Pryce [Abstr. 374 (1953)]. P. T. MATTHEWS

539.152.2

6806. The nuclear spin of Si^{29}. G. A. WILLIAMS, D. W. MCCALL AND H. S. GUTOWSKY. Letter in *Phys. Rev.*, **93,** 1428 (*March* 15, 1954).

The spin of Si^{29} is confirmed as $\frac{1}{2}$ from the splitting of the F nuclear resonance signal in $Si^{29}F_4$ into 2 peaks 46 milligauss apart. D. H. WHIFFEN

539.152.2 : 535.343.4–14

6807. Determining 0 and $\hbar/2$ spins of nuclei from microwave spectra of molecules. A. M. PROKHOROV AND N. G. BASOV. *Dokl. Akad. Nauk SSSR,* **90,** *No.* 6, 1003–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-169.

Spins of 0 or $\frac{1}{2}$ may be determined from the statistical weights of various energy levels which affect the intensity of microwave transitions, e.g. for C_{3v} XYZ_3 molecules the levels with K not a multi of 3 are absent when the spin of Z is 0. D. H. WHIF

539.

6808. On an analytic approximation procedure the determination of eigenfunctions and energy eig values of atomic electrons. II. Calculation of higher energy levels. The electron structure of Se atom. R. GÁSPÁR AND P. GOMBÁS. *Acta ph Hungar.*, **2,** *No* 4, 335–43 (1952) *In German.*

The method of Pt I [Abstr. 2625 (1953)] is gene lized to the case when there are several electrons w the same l by modifying the effective potential in Schrödinger equation to take account of the exclusi principle, using the method of Abstr. 9002 (195 Application to the spectrum of Se yields energies *s*, *p*, *d* electrons in reasonable agreement with periment. W. J. SWIATEC

539.1

6809. On the radiation damping and the decay of excited state. M. NAMIKI AND N. MUGIBAYAS Letter in *Progr. theor. Phys.*, **10,** 474–6 (*Oct.*, 1953)

E. T. Hellund's conclusion [Abstr. 3528 (1953)] th excited states do not decay according to the Weissko Wigner law is followed up, and it is shown that t law represents an asymptotic expression for extre values of certain parameters. W. A. HEPN

539.1

6810. The low even configurations of Hf II. GEHATIA. *Phys. Rev.*, **94,** 618–19 (*May* 1, 1954).

The experimental energy levels and g values of t low even configurations ds^2, d^2s, and d^3 of Hf II, a compared with the theoretical formulas for inte mediate coupling with configuration interaction. T energy levels are in good agreement, while the me error is less than 0·7% of the configuration width; t agreement between calculated and observed g valu is satisfactory.

539.15

6811. Approximate eigensolutions of

$$\frac{d^2\varphi}{dx^2} - \left[k^2 + \frac{l(l+1)}{x^2} - b\frac{e^{-x}}{x}\right]\varphi = 0$$

for *s*-, *p*- and *d*-states. K. V. LAURIKAINEN AND E. EUPANTO. *Ann. Univ. Turku A,* **9,** *No.* 3, 34 *pp.* (195

Starting from an improved trial function for $l =$ readily generalized for higher values of l, the par meters are determined by the Ritz method, a numerical results for the eigenvalues are given. W. A. HEPN

539.153

6812. On Weizsäcker's inhomogeneity correction the statistically calculated kinetic energy. P. GOMBÁ *Acta phys. Hungar.*, **3,** *No.* 2, 105–25 (1953) German.

It is shown that the usual method of addi Weizsäcker's correction to the Fermi energy of a electron gas overcompensates. The error is calc lated for a particular model. F. ANSBACHE

539.153

6813. On a kinetic energy correction in the stati tical model of the atom. P. GOMBÁS. *Acta phy Hungar.*, **3,** *No.* 2, 127–53 (1953) *In German.*

The correction to the energy which includes t Weizsäcker contribution, is derived. A variation

nciple and an equivalent integro-differential iation for the determination of the electron density l potential distribution is set up. The energy of ms is calculated to the first approximation from variational principle by Ritz's method. An addinal correction permits the extension of the method even the lightest atoms. The calculated energies m the lightest to the heaviest atoms are in excellent eement with empirical, semi-empirical, and wave chanical values. The greatest discrepancy is less n 3%, compared with 50% for the older method. e electron density remains finite at the nucleus and creases exponentially for large distances, in agreent with wave mechanical results. F. ANSBACHER

539.153.4

14. A complete Bacher and Goudsmit method. MESHKOV AND C. W. UFFORD. *Phys. Rev.*, **94**, –6 (*April* 1, 1954).

A complete Bacher and Goudsmit method for the lculation of atomic energy states in terms of the perimentally observed energies of ions of higher nization is developed. The method has been tended to include configurations containing elecons of any angular momentum. A term in d^4 is lculated as an example. A.

539.153.4

15. Application of the Rayleigh–Schrödinger rturbation theory to the hydrogen atom. E. P. IGNER. *Phys. Rev.*, **94**, 77–8 (*April* 1, 1954).

The motion of a single electron in the electrostatic ld of a nucleus is treated by the Rayleigh–Schröger perturbation method, the whole electrostatic otential being considered as the "perturbation." he contribution of the first approximation to the ergy vanishes. The second approximation gives a nite ionization energy which is, however, incorrect umerically. The first approximation also vanishes r potentials $\sim r^{-n}$ with $0 < n < 3$ but the second pproximation is finite only for $n = 1$: it vanishes for > 1, and is infinite for $n < 1$. A.

539.154

16. Determination of h/e by a new method. F. G. UNNINGTON, C. L. HEMENWAY AND J. D. ROUGH. *Phys. Rev.*, **94**, 592–8 (*May* 1, 1954).

A new method for the direct determination of h/e as been developed which does not involve the shortavelength limit of the continuous X-ray spectrum. he excitation potential V_e of helium from the ground tate to the $2p^1P_1{}^0$ state is measured as the energy, in lectron volts, lost by electrons causing this excitaion. Experimentally, this energy is determined as he difference between two voltages. The value of h/e s calculated from the basic equation $h\tilde{\nu}c = V_e e$; here is the wave number of the radiation from helium in he $2p^1P_1{}^0$ state. Four factors make possible an rder-of-magnitude increase in precision over other arlier work dependent on excitation or ionization otentials: (1) the difference method of obtaining the xcitation potential; (2) a gold evaporation technique which essentially eliminates contact potentials and nakes possible a great reduction in surface charges; 3) the high precision in both the slit system and in the niformity of the magnetic field; and (4) the fact that he absolute magnitudes of the electron beam energy, the magnetic field, and the work function of the cathode do not need to be known. A total of 156 determinations of h/e were made under varying experimental conditions. A multiple correlation analysis of these data shows no significant variation of h/e with experimental conditions. The value obtained with its standard error is $h/e = (1{\cdot}3790 \pm 0{\cdot}0002) \times 10^{-17}$ erg. sec/e.s.u. This value is in fairly good agreement with the values found from the short-wavelength limit of the continuous X-ray spectrum and with the indirect value computed from all significant work on atomic constants. A.

539.154.2

6817. The periodic table and its applications. S. I. TOMKEIEFF. *Nature* [*London*] **173**, 393–5 (*Feb.* 27, 1954).

Using the spiral periodic table as a co-ordinate net, numerical data associated with the elements are plotted in the form of a contour map. Three maps are given, of the magnetic susceptibility surface, of the "heat of formation of oxides" surface, and of the "average composition of granite" surface. It is suggested that the spiral periodic table can provide a symbolic representation of the electronic structure of an atom. J. HUGHES

539.155

6818. Mass assignments by isotope separation. M. C. MICHEL AND D. H. TEMPLETON. Letter in *Phys. Rev.*, **93**, 1422–3 (*March* 15, 1954).

A high transmission (~20%) time-of-flight isotope separator with a separation factor between adjacent isotopes $\gtrsim 100$ for $A = 100$–250 and calibrated absolutely was used; isotopes of Cs, Tl and the heavy rare earths Yb, Tm and Er were examined and are reported. A. O. STANESBY

539.155.2

6819. [A] model experiment for continuous isotope separation. J. HENGEVOSS AND R. FLEISCHMANN. *Z. Phys.*, **137**, *No.* 3, 265–73 (1954) *In German.*

A cylindrical thermal diffusion tube was run with air. The N_2 concentration at the top was determined as a function of the throughput. As long as this is $<1/10$ of the circulation the dependence agrees with theory. From the measurements the separation constants of the tube could be obtained with 3% accuracy. H. LONDON

539.155.2

6820. Influence of a throughput on the separation effect in Clusius–Dickel separation tubes. E. DAVID. *Z. Phys.*, **137**, *No.* 3, 274–9 (1954) *In German.*

Theory gives no such effect in an ideal tube. Deviations found at large throughput (see preceding abstract) are attributed to the presence of spacers which interrupt the circulation. H. LONDON

539.155.2

6821. Isotope analysis of "common lead." J. GEISS. *Z. Naturforsch.*, **9a**, 218–27 (*March*, 1954) *In German.*

Thirty samples of naturally occurring lead free from radioactive material were analysed with a 60° mass-spectrometer to determine isotope abundances. The isotope ratio shows a significant variation and an attempt to explain this in terms of existence in a liquid state along with radioactive material followed by separation on crystallization is given. J. M. HOUGH

539.155.2 : 539.16.08

6822. Measurement of the tritium concentration in natural waters by a diffusion cloud chamber. E. L. FIREMAN AND D. SCHWARZER. *Phys. Rev.*, **94**, 385–8 (*April* 15, 1954).

The radioactivity of tritium is easily recognized and visually counted in a hydrogen-filled diffusion chamber. A 6 in. dia. diffusion chamber, filled with 100 lb/in.^{2} of hydrogen obtained by completely converting 14 cm^3 of water in a Mg furnace, was used to measure the tritium concentration in surface water of the Long Island Sound, in New Jersey well water, and in a number of rain and atmospheric moisture samples. These samples had tritium concentration (T/H ratios) that ranged from 10^{-15} to 3×10^{-18}. Some samples were measured directly, others required some electrolysis to give measurable tritium concentrations. No tritium could be detected in glacial water. A.

RADIOACTIVITY . α-, β- and γ-RAYS 539.16

539.16.08

6823. Photovoltaic scintillation detector for high dose rates. R. L. SCHUCH, R. D. HIEBERT, F. N. HAYES AND B. ROGERS. *Nucleonics*, **12**, 16–18 (*Feb.*, 1954).

The detector consists of a 4 in. dia. photovoltaic cell used in conjunction with a variety of organic plastic and liquid scintillators in a flat cylindrical Pyrex cell. The detectors were tested with a source of 20 000 curies giving γ-radiation of mean energy 1·3 MeV and the output current from the photocell was found to vary linearly over a range of dose rates from 12 000 to 360 000 r/hr. A plastic scintillator, 4% terphenyl, 0·025% 1, 1, 4, 4-tetraphenylbutadiene in polyvinyltoluene, gave the highest sensitivity, viz. $4\cdot2\times10^{-4}$ μA/r.hr. L. R. SHEPHERD

539.16.08

6824. The counting of low-level activities. A. R. CRATHORN. *Atomics* [*London*] **5**, 99–102 (*April*, 1954).

Methods of reducing the background counting rates of G.M. and proportional counters are discussed, with particular reference to the measurement of the low specific activities of archaeological specimens of C^{14}. G.M. tubes with mild steel cathodes have lower background counting rates than those with glass, brass, aluminium or stainless steel cathodes, and the use of glass and lead solder should be kept to a minimum because of K^{40} and Pb^{210} activity. Lead used for shielding must be old in order to reduce the background due to Pb^{210} (half-life 22 years) and a combined shield of lead and steel is more effective. The background due to cosmic rays can be reduced by surrounding the counter with other counters and subtracting coincidence counts. Higher counting efficiencies for C^{14} were obtained by using the sample in a gaseous form as a filling for a large counter. The pressure used was about atmospheric and consequently the tube could not be used in the G.M. region but reproducible results were obtained by using corona-stabilized h.t. supplies. Residual background pulses could be biased out to some extent. It is suggested that large counters filled w the radioactive sample in gaseous form could more widely used in the estimation of sources of s radiation of low specific activity. D. R. CH

539.

6825. On the nuclear isomerism in vanadium dysprosium 165 and iridium 192. G. WEBER. *Naturforsch.*, **9a**, 115–24 (*Feb.*, 1954) *In German.*

An examination of the 3·77 min radiation fr V^{52} by means of a Slätis–Siegbahn β-spectrom failed to show soft electrons, indicating the abse of an isomeric state [compare Renard, Abstr. (1951)]. The electron spectra of Dy^{165} (2·42 h) a Dy^{165m} (1·25 min) showed *K*- and *L*-conversion li of 92·7, 106·2 keV γ's, suggesting a mixed $M1+$ and an $E3$ transition respectively. The cross-sect for the formation of Dy^{165m} by thermal neutrons v (507 ± 14) barns. The spectrum of Ir^{192m} show only *K* and *L* conversions of a 56·0 keV γ, but continuum. A decay scheme is constructed.

W. J. SWIATE

539.

6826. Long-lived isomer of RaE (Bi^{210}). H. LEVY AND I. PERLMAN. *Phys. Rev.*, **94**, 152–5 (*April* 1954).

The mass assignment of a long-lived bism α-activity previously reported [Abstr. 5219 (1950)] being an isomer of Bi^{210} has been confirmed by me of electromagnetic mass separation. The half-life the Bi^{210} (long) is now reported to be $2\cdot6\times10^6$ The α-decay energy of Bi^{210} (long) has been determined and found to be 5·031 ± 0·020 Me Comparison with the α-decay energy of RaE pla the Bi^{210} (long) 25 keV below RaE with, however, uncertainty of the same order of magnitude. B (long) has measurable β^--branching (1 part in 270) give Po^{210}, and this gives a partial half-life $7\cdot0\times10^8$ yr for this mode of decay. An unsuccess search was made for Bi^{210} (long) as a decay product RaD (Pb^{210}), resulting in a lower limit of 2×10^7 for the decay of RaD to this isomer. Also, an up limit of $1\cdot4\times10^4$ yr was set on the half-life for transition from RaE to Bi^{210} (long). On the basis decay data now available, the most probable desig tion for the Bi^{210} (long) state is deduced to be 4 although a somewhat higher spin number could possible.

539.16

6827. Half-lives of Pu^{240} and Pu^{239}. G. W. F WELL, J. E. ROBERTS AND A. C. WAHL. *Phys. Re* **94**, 363–4 (*April* 15, 1954).

The half-lives of Pu^{240} and Pu^{239} have been det mined by measuring the specific α-activity and t Pu^{240} content of four plutonium samples which h received different amounts of neutron irradiatio With the assumption that Pu^{238} contributes 13% the observed increase in α-activity, the half-life Pu^{240} is 6300 ± 600 yr. The half-life of Pu^{239} is fou to be 24 400 ± 500 yr.

539.16

6828. A new isotope of palladium, 1·5-minute Pd^{1} H. G. HICKS AND R. S. GILBERT. *Phys. Rev.*, 9 371 (*April* 15, 1954).

A new isotope, 1·5 min Pd^{113}, has been isolat

om the fission products of natural uranium mbarded with 190 MeV deuterons. The mass signment and half-life were determined by successive lkings of the 5·3 hr Ag^{113} daughter. A.

539.163.2

29. A new isomer in lead. D. MAEDER AND H. WAPSTRA. Letter in *Phys. Rev.*, **93**, 1433 *March* 15, 1954).

Irradiation of Tl with 26 MeV deuterons yields a $5 \pm 0{\cdot}1$ hr activity attributed to Pb^{202*}. The lative intensities and internal conversion coefficients γ-rays of 123, 322, 416, 455, 657, 784 and 957 keV ergy were measured using scintillation counters and β-spectrometer. A decay scheme and spin assignents are discussed. M. A. GRACE

539.163.2

330. Evidence for Si^{32}, a long-lived beta emitter. . TURKEVICH AND A. SAMUELS. *Phys. Rev.*, **94**, 54 (*April* 15, 1954).

Neutron-irradiated quartz has been found to ontain 14·3 day P^{32} more than two years after the nd of irradiation. This is evidence for a long-lived i^{32} formed from stable Si^{30} by the capture of two eutrons. The ratio of half-life of Si^{32}, in years, to eutron capture cross-section of Si^{31}, in barns is 00. A.

539.163.2

831. Neon-18. J. D. GOW AND L. W. ALVAREZ. *hys. Rev.*, **94**, 365–7 (*April* 15, 1954).

A new radioactivity which is assigned to the nucleus Ne^{18} has been investigated. The decay is by the mission of positrons with an upper limit of $3{\cdot}2 \pm$ ·2 MeV and a half-life of 1·6 sec. The spectrum of -rays was compared directly in a magnetic spectroraph with the known radiation of He^6. The β-ray nergy and decay rate correspond to a log ft value f $2{\cdot}9 \pm 0{\cdot}2$, placing the activity in the superallowed lass. A.

539.163.2

832. Radioisotope P^{33}. R. T. NICHOLS AND E. N. ENSEN. *Phys. Rev.*, **94**, 369–71 (*April* 15, 1954).

Radioactive phosphorus has been obtained by an t, p reaction on sulphur which had been electromagnetically enriched in S^{33}. The β-spectrum of hosphorus showed an increase in the low-energy -group approximately proportional to the isotopic nrichment. This confirms the previous identification f this activity with P^{33}. The maximum β-energy was letermined from several Kurie plots and found to be ·249 $\pm$ 0·002 MeV. The half-life was found to be 4·4 $\pm$ 0·2 days. The spectrum appears to have an allowed shape as is expected from theoretical onsiderations. A.

539.163.2

5833. The radiations of lanthanum^{140}. C. L. PEACOCK, J. F. QUINN AND A. W. OSER, JR. *Phys. Rev.*, **94**, 372–3 (*April* 15, 1954).

The radiations of La^{140} have been studied with a magnetic spectrometer of radius 20 cm. The β-spectrum is complex consisting of five groups whose maximum energies are: 0·83 MeV, 1·10 MeV, 1·34 MeV, 1·67 MeV and 2·15 MeV. γ-rays with energies of 0·110 MeV, 0·130 MeV, 0·240 MeV, 0·270 MeV, 0·328 MeV, 0·485 MeV, 0·815 MeV and 1·60 MeV, respectively, were found. The 1·60 MeV gamma is very intense. A tentative decay scheme is proposed. A.

539.163.2

6834. The disintegration of Co^{55} and I^{130}. R. S. CAIRD AND A. C. G. MITCHELL. *Phys. Rev.*, **94**, 412–19 (*April* 15, 1954).

The nuclear spectra of Co^{55} (18 hr) and I^{130} (12·6 hr) have been studied with the help of a magnetic lens spectrograph, a coincidence lens, and scintillation counters. Co^{55} emits γ-rays having energies 0·477, 0·935, 1·41, 0·253, 1·84 and 2·17 MeV, the last three being quite weak; and four β-ray groups of energies 1·500, 1·03, 0·53 and 0·26 MeV with relative abundances of 53·3, 39·5, 4·9 and 2·3%, respectively. A disintegration scheme is proposed. I^{130} emits γ-rays of energy 0·409, 0·528, 0·660, 0·744 and 1·15 MeV together with two β-ray groups of energies 1·02 and 0·597 MeV. The energy-level scheme is discussed in the light of the collective model. A.

539.164

6835. On the magnetic α-spectrum of thorium C and thorium C′. A. RYTZ. *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 254–6 (*Dec.*, 1953) *In French.*

Lines at 6·163, 6·203, 5·876, 5·711, 5·730, 5·586 MeV in ThC and 8·946, 10·739, 9·671, 10·617 MeV in ThC′ (but no others) were observed. Experimental details are given. W. J. SWIATECKI

539.164

6836. Decay properties of Am^{243} and possible rotational bands in the alpha spectra of odd-even nuclei. F. ASARO AND I. PERLMAN. Letter in *Phys. Rev.*, **93**, 1423 (*March* 15, 1954).

Three α-groups of 5·171, 5·225, 5·267 MeV and intensities 3, 13, 84% were observed with a magnetic spectrograph. They can be interpreted as decays to excited rotational levels of Np^{239} at 75, 118, 172 keV, analogous to the 60, 103, 159 keV levels of Np^{237} observed in Am^{241} decay. W. J. SWIATECKI

539.164 : 539.163.2 : 778.34

6837. Measurement of the branching ratio of thorium C by a photographic method. S. TOKUNAGA. *Mem. Coll. Sci. Univ. Kyoto A*, **26**, 109–12 (*Oct.*, 1950).

Th B and C in equilibrium, deposited on a copper disk, was placed in contact with a nuclear emulsion plate. From 6792 α-particle tracks due to Th(C + C′) 4484 were attributed to ThC′, identified by their greater range, a correction being made for the dip of the tracks. A value of $0{\cdot}6601 \pm 0{\cdot}0028$ for the ratio of the number of tracks due to ThC′ to that due to Th(C + C′) was obtained. M. A. GRACE

539.164 : 539.166

6838. The alpha- and gamma-ray spectra of Pu^{238}. F. ASARO AND I. PERLMAN. *Phys. Rev.*, **94**, 381–5 (*April* 15, 1954).

These have been studied with an α-particle spectrograph and γ-ray scintillation and proportional counters. Alpha-groups of 5·495 (72%), 5·452 (28%) and 5·352 MeV (0·09%) and electromagnetic radiations of 17 (13%), $43{\cdot}8 \pm 0{\cdot}5$ (0·038%), 99 ± 2 (0·008%) and 150 ± 2 keV (0·001%) were observed. Spins and parities are assigned to the energy levels, and the results are evaluated with respect to the

developing theory and systematics of complex α-spectra and excited states of even-even nuclei. A.

539.165

6839. β-spectra of Fe^{59}, Rb^{87}, Tc^{99}, Cs^{137} and the coupling constants of scalar and tensor interactions in β-decay. M. MORITA, J. FUJITA AND M. YAMADA. *Progr. theor. Phys.*, **10**, 630–40 (*Dec.*, 1953).

The β-spectra of Fe^{59}, Rb^{87}, Tc^{99} and Cs^{137} are investigated with the linear combination of scalar and tensor interactions in the Fermi theory of β-decay, and it is inferred that the relative sign between two coupling constants of scalar and tensor interactions is minus. A.

539.165

6840. Determination of the disintegration energy of some light elements by counter-absorption methods. L. KOESTER. *Z. Naturforsch.*, **9a**, 104–14 (*Feb.*, 1954) *In German.*

Using a continuous-flow proportional counter (CH_4 at atm. press.), the Al absorption curves of several short-lived β-emitters of low Z were measured; where γ-radiation is also emitted, the mean γ-energy per β-disintegration was also obtained, giving the total disintegration energies, as follows: $F^{17}(\beta^+$, ½-life $66{\cdot}0 \pm 0{\cdot}5$ sec), $1{\cdot}76^{\pm 0{\cdot}15}_{-0{\cdot}05}$; $Mg^{27}(\beta^-$, $9{\cdot}51 \pm 0{\cdot}03$ min), $2{\cdot}68$; $P^{30}(\beta^+$, $2{\cdot}55 \pm 0{\cdot}02$ min), $3{\cdot}23^{\pm 0{\cdot}17}_{-0{\cdot}07}$; $Sc^{49}(\beta^-$, 57 ± 1 min), $2{\cdot}0 \pm 0{\cdot}05$; $V^{47}(\beta^+$, $31{\cdot}1 \pm 0{\cdot}1$ min), $1{\cdot}90^{\pm 0{\cdot}1}_{-0{\cdot}04}$; $V^{52}(\beta^-$, $3{\cdot}77 \pm 0{\cdot}01$ min), $3{\cdot}92 \pm 0{\cdot}1$; $Mn^{51}(\beta^+$, $45{\cdot}2 \pm 0{\cdot}4$ min), $2{\cdot}16^{\pm 0{\cdot}15}_{-0{\cdot}05}$ $Cu^{66}(\beta^-$, $5{\cdot}20 \pm 0{\cdot}05$ min), $2{\cdot}60 \pm 0{\cdot}05$; Ga^{65} (β^+, 15 ± 1 min), $2{\cdot}1^{\pm 0{\cdot}4}_{-0{\cdot}1}$ and $Ga^{68}(\beta^-$, 68 ± 1 min), $1{\cdot}90^{\pm 0{\cdot}14}_{-0{\cdot}04}$ MeV. A. O. STANESBY

539.165

6841. On the *L*-capture to *K*-capture ratio in Cd^{109}. G. BERTOLINI, A. BISI, E. LAZZARINI AND L. ZAPPA. *Nuovo Cimento*, **11**, 539–50 (*May*, 1954).

The *L*-capture to *K*-capture ratio in the orbital electron capture occurring in Cd^{109} was measured by means of a proportional counter. This ratio was deduced from the measured intensities of the *LX*- and *KX*-radiations, after correction for the counting geometry, the fluorescence yields of Ag, and the internal conversion of 87 keV γ-rays from the atom produced. Thus: $P_L/P_K = 0{\cdot}32 \pm 0{\cdot}04$. A test of this result was obtained by measuring the intensities of the *KX*- and γ-radiations by means of a NaI(Tl) γ-ray spectrometer. In this way: $P_L/P_K \simeq 0{\cdot}29$. Marshak's formulae were used to calculate the transition energy E_0; the result found was $E_0 = 67^{+8}_{-3}$ keV. A.

539.165

6842. Beta-ray spectrum of Ag^{110}. T. AZUMA. *Phys. Rev.*, **94**, 638–9 (*May* 1, 1954).

The soft β-ray spectrum of Ag^{110} has been measured by a double coil, magnetic lens β-ray spectrometer, with a thin source and a thin counter window. From the analysis of the Fermi plot, three soft β-ray groups of allowed type are found, with end points of 80 keV, 314 keV and 530 keV. The ratio of their intensities is $10{\cdot}7 : 3{\cdot}2 : 15{\cdot}3$. A.

539.165 : 539.166

6843. Some results on the nuclear spectra of Rb^{86} and Cs^{137}. P. MACQ. *Ann. Soc. Sci. Bruxelles*, **67**, *Sér.* 1, *No.* 3, 309–17 (1954) *In French.*

A thin lens β-spectrometer is described: this was used to show that the β^--spectrum of Cs^{137} has fir forbidden form ($E_{max} = 526 \pm 5$ keV). Rb^{86} has hard β^--component ($E_{max} = 1760 \pm 9$ keV) wi first-forbidden form and a soft component (E_{max} 715 ± 20 keV). A single γ-ray of 1055 ± 4 keV w found; assignment of spins from this and β-γ angul correlation measurements is discussed. M. A. GRA

539.165 : 539.1

6844. Spectra of conversion electrons emitted in t transmutations radiothorium → thorium X → thor S. ROSENBLUM, M. VALADARES AND M. GUILLO *J. Phys. Radium*, **15**, 129–33 (*March*, 1954) *In Fren*

Measurements with a 180° magnetic spectrome are reported. Six RTh → ThX conversion lines we detected, consistent with a single $E2$ γ-ray transiti (84·47 keV). Similarly four (weak) ThX → Tn lin were detected, again consistent with a single $E2$ γ-ra transition (241 keV). J. J. WILKI

539.165 : 539.1

6845. The β-γ angular correlation of Sb^{12} M. MORITA AND M. YAMADA. Letter in *Progr. theo Phys.*, **10**, 111–13 (*July*, 1953).

Comparison of calculation and experiment on t β-spectrum and β-γ correlation in the decay Sb^{124} — $Te^{124m} \rightarrow Te^{124}$ gives reasonable agreement for spi $3(-) - 2(+) - 0(+)$ (1st-forbidden, scalar + tens interaction); further calculations for 4–2–0 are pr ceeding. A. O. STANES

539.165 : 539.1

6846. On the β-γ angular correlation of Sb^{124}. I M. MORITA AND M. YAMADA. *Progr. theor. Phys* **10**, 641–52 (*Dec.*, 1953).

For Pt I, see Abstr. 8660 (1953). A consiste explanation of both the β-γ angular correlation an the β-ray spectrum of Sb^{124} is obtained with the S type interaction in the Fermi theory of β-decay. is concluded that (i) the decay scheme is $3(-)$ $2(+) - 0(+)$, (ii) the β-decay is a first-forbidde transition which contains the reduced nuclear matri elements $\mathfrak{M}(\beta \boldsymbol{r})$, $\mathfrak{M}(\beta\alpha)$, $\mathfrak{M}(\beta\sigma \times \boldsymbol{r})$ and $\mathfrak{M}(B^{\beta}_{ij})$, an (iii) the γ-decay is an electric quadrupole radiatio It is also noticed that $4(+) - 2(+) - 0(+)$ is rule out. A

539.165.

6847. Note on the finite nuclear size effect in beta decay. M. YAMADA. Letter in *Progr. theor. Phys* **10**, 241–3 (*Aug.*, 1953).

The first-forbidden transition is considered and th correction factor is calculated. G. E. BROW

539.165.

6848. On the interaction forms of the beta-decay Y. TANIKAWA. Letter in *Progr. theor. Phys.*, **1** 361–2 (*Sept.*, 1953).

An alternative interaction Hamiltonian satisfyin the same postulates as that of Y. Tanikawa an K. Saeki (1953) is pointed out. W. J. SWIATEC

539.165.

6849. Interference terms of beta-ray angular correla tions. M. MORITA. Letter in *Progr. theor. Phys.*, **1** 363–4 (*Sept.*, 1953).

Beta-ray angular distribution functions $F_{LL'}{}^{M}(\theta)$ fo interference between various types of interactions a given. G. E. BROW

539.165.2

50. Note on coexistence of tensor and axialvector eractions in beta-decay. M. MORITA. Letter in *ogr. theor. Phys.*, **10**, 364–6 (*Sept.*, 1953).

If the Wigner type of invariance under time reversal not adhered to, these two interactions may coexist. nsequences of this for the angular distribution are cussed. G. E. BROWN

539.165.2

51. Effect of collective motion on beta decay. SUEKANE. Letter in *Progr. theor. Phys.*, **10**, 480–1 *ct.*, 1953).

The collective motion tends to reduce transition obabilities as a result of partial orthogonality of fferent states. The result of this reduction is com- ated theoretically from the model of A. Bohr and mpared with experiment. G. E. BROWN

539.165.2

52. On the coupling constants in β-decay. Evi- ence from allowed transitions. A. WINTHER AND . KOFOED-HANSEN. *K. Danske Vidensk. Selsk., at.-fys. Medd.*, **27**, *No.* 14, 22 *pp.* (1953).

An investigation of nuclear matrix elements is ombined with the experimental *ft*-values in order to etermine the coupling constants for Fermi– and amow–Teller interaction in β-decay. It is shown nat the mirror transitions between nuclei with closed helis $\pm$ one nucleon are consistent with approxi- nately equal amounts of the two couplings. Within he limits of error, this result agrees with similar alculations carried out by Trigg, Bouchez and Nataf, nd Blatt. For the remaining mirror transitions, the natrix elements derived from the shell model are not onsistent with this result. However, as pointed out y Trigg, considerable improvement can be obtained y adjusting the wave functions to the observed agnetic moments. In the present paper, it is shown hat, on the assumption of an interaction between the single particle and the nuclear core, an approximate correlation exists between the Gamow–Teller matrix elements and the magnetic moments of the nuclei involved in the transitions. The results for the adjusted matrix elements thus obtained are, within the uncertainties and the approximation, in agree- ment with the above-mentioned coupling constants. The possible existence of cross terms in the β-decay coupling is also discussed. It is shown that the present experimental data do not provide very narrow limits for these terms, and further experiments are therefore desirable. A.

539.165.2

6853. The β-decay of radium E and the pseudoscalar interaction. A. G. PETSCHEK AND R. E. MARSHAK. Letter in *Phys. Rev.*, **85**, 698–9 (*Feb.* 15, 1952).

539.165.2

6854. On the pseudoscalar interaction in β-decay. G. ALAGA, O. KOFOED-HANSEN AND A. WINTHER. *K. Danske Vidensk. Selsk., mat.-fys. Medd.*, **28**, *No.* 3, 10 *pp.* (1953).

Assuming the β-decaying nucleon to move in a simple scalar potential, the Foldy–Wouthuysen transformation is used to obtain an equivalent non-relativistic form for the pseudoscalar interaction. The effect of the recoil of the nucleus has been taken into account. The observed shapes of allowed β-spectra permit an estimate of an upper limit to the pseudo-scalar coupling constant, which is difficult to reconcile with the value derived from the analysis by Petschek and Marshak (preceding abstract) of the RaE spectrum. This conclusion is dependent on the assumption of a simple nuclear potential. A.

539.165.2 : 530.145

6855. Pseudoscalar interaction in the theory of beta-decay and RaE. H. TAKEBE. *Progr. theor. Phys.*, **10**, 673–89 (*Dec.*, 1953).

The correction factors for linear combinations of pseudoscalar and tensor interaction, and of pseudo-scalar and axial vector interaction for the first for-bidden $0 \rightarrow 0$ (yes) transition are deduced by taking into consideration : (i) the effect of the finite size of the nucleus, (ii) the contribution of a term which contains a derivative of the lepton wave function in the case of pseudoscalar interaction. The β-ray spectrum of RaE is examined by the linear combina-tion of pseudoscalar and tensor interaction. A.

539.165.2 : 530.145

6856. The pseudoscalar interaction and the beta spectrum of RaE. M. E. ROSE AND R. K. OSBORN. *Phys. Rev.*, **93**, 1315–25 (*March* 15, 1954).

It is shown that the theory of forbidden β-transi-tions, as hitherto used, does not provide a correct treatment of the pseudoscalar interaction. This is demonstrated by the application of a canonical transformation to the Hamiltonian of interacting nucleons and leptons whereby all odd nuclear Dirac operators are eliminated from the theory. When this is done properly it is seen that the pseudoscalar interaction makes a contribution to the β-decay process only by virtue of the fact that the lepton covariants are not constant. The corresponding additional operators introduced in the other three interactions (S is pure even) are examined and it is shown that, except in one case, these make trivial corrections which would not be observed in practice. The exception occurs in second and higher forbidden transitions wherein the spin change (tensor rank, strictly speaking) is lower than the forbiddenness order. By virtue of present knowledge of the beta interaction these must be regarded as small correction terms. The possibility of calculating all nuclear matrix elements using nonrelativistic wave functions based on some coupling model is discussed. The results presented here also show that wherever P and T interactions interfere (spin change zero, first-forbidden transitions) it will be possible to obtain the ratio of coupling coefficients (g_P/g_T, for example) by comparison with the observed spectral shapes. A method of reduction of the β-decay operators is described and it is pointed out that the same procedure is very convenient for obtaining the nuclear matrix elements. In this method the irreducible tensors are obtained automatically and the retardation expansion is a trivial operation performed at the end of the calculation rather than at the beginning. The correc-tion factors for pseudoscalar (P) as well as P–T and P–A mixtures are obtained and the fact that the shape of the correction factor is strongly modified as com-pared to the customary result is observed. The correction factor is now more strongly Z-dependent

and this would perhaps account for the appearance of the P interaction only for heavy elements. The results of this investigation are applied to the RaE spectrum. No fit with the assumption of zero spin for RaE can be obtained. It is suggested that the spin of RaE is unity, and other evidence pointing in this direction is cited. A.

539.165.2

6857. Nuclear matrix elements in beta decay. M. E. Rose and R. K. Osborn. *Phys. Rev.*, **93**, 1326–36 (*March* 15, 1954).

By using the *j-j* coupling model, all the β-decay nuclear matrix elements are calculated (in terms of radial integrals) for one- and two-nucleon configurations. The operators in terms of which one can describe the entire theory are of five types. Three of these, involving the nucleon momentum operator, replace the operators which, in the conventional representation of the theory, appeared as odd Dirac operators. The operators in the present representation, which is most naturally expressed in terms of spherical notation and angular momentum eigenfunctions, are explicitly related to those which appeared in the older notation as Cartesian tensor components. The results for both one- and two-nucleon configurations are expressed in terms of reduced matrix elements which, in turn, can be written in terms of Racah coefficients and other coefficients derived from them. All these coefficients, and thereby the reduced matrix elements, can be written in terms of comparatively simple algebraic formulæ which cover all cases of interest. A brief discussion of the implications of these results for spectral shapes and comparative half-lives is given. A.

539.165.2

6858. A possible relation between the pseudoscalar β coupling and the nuclear spin-orbit coupling. E. J. Konopinski. *Phys. Rev.*, **94**, 492–3 (*April* 15, 1954).

It is suggested that there is a direct proportionality between the nuclear spin-orbit energy and the size of the nuclear moments responsible for β-decay via pseudoscalar coupling. On this assumption, the observed size of the spin orbit splitting is adequate to account for the large β-moment needed for explaining the RaE spectrum, within the uncertainties in the knowledge of these phenomena. A.

539.166

6859. Influence of extranuclear fields on angular correlations. F. Coester. *Phys. Rev.*, **93**, 1304–8 (*March* 15, 1954).

General formulas exhibiting the influence of extranuclear fields on angular correlations of two or three successive γ-rays are derived from first principles. They are applicable to polarization correlations as well as to directional correlations. The effect of transitions in the electron shell during the life of the intermediate nucleus is discussed briefly. A.

539.166

6860. Internal bremsstrahlung accompanying the β-disintegration of P^{32} and Y^{90}. A. Michalowicz. *J. Phys. Radium*, **15**, 156–60 (*March*, 1954) *In French.*

This has been studied with a scintillation spectrometer, giving results in agreement with theory. The measurements were not sufficiently accurate to distinguish between allowed and forbidden transitions. The production of characteristic X-rays in Pb, Ta and Sn under bombardment by the β-rays of P^{32} and Y was also studied. J. J. Wilkins

539.16

6861. Internal bremsstrahlung from P^{32}. M. Goodrich and W. B. Payne. *Phys. Rev.*, **94**, 405– (*April* 15, 1954).

The spectral distribution of the internal bremsstrahlung associated with the β-decay of P^{32} has been measured with a NaI scintillation spectrometer from 80 to 900 keV. The shape of the experimental spectrum is compared with the theoretical distribution, corrected for detector response, for three different β-interactions: (1) allowed; (2) first-forbidden; scalar; (3) first-forbidden; tensor; $\Delta J = 1$ yes. The results show that of these interactions, only the allowed case gives a theoretical curve within the estimated error (10%) of the experimental points over the entire range of energy. A

539.16

6862. Inner bremsstrahlung of Cs^{131}. B. Sarah *Phys. Rev.*, **94**, 642–7 (*May* 1, 1954).

The continuous γ-ray spectrum (inner bremsstrahlung), accompanying orbital electron capture in Cs^{13} has been observed by the method of scintillation spectrometry. The absolute intensity of the γ-radiation has been measured and compared with the total disintegration rate. The end point of the γ-ray distribution was found to be 320 ± 10 keV. The experimentally determined shape of the spectrum, as well as the intensity of the continuum, is compared with theoretical calculations. The disagreement exceeds considerably that which might be expected from a consideration of the probable errors of the observations. The growth of the 12-day isomer of Xe^{131} was not detected. A

539.166 : 539.172.1

6863. Gamma radiation from proton bombardment of Li^7. A. A. Kraus, Jr. *Phys. Rev.*, **93**, 1308–10 (*March* 15, 1954).

The capture γ-rays from the reaction $Li^7(p, \gamma)$ have been investigated by measuring excitation functions and angular distributions. In addition to the well-known resonance at 441 keV, the excitation curve exhibits resonance at 1030 keV in proton bombarding energy corresponding to an excited state at 18·14 MeV in Be^8. Near this resonance the γ-rays have a non-isotropic angular distribution with fore-and-aft asymmetry. The yield integrated over this resonance corresponds to a radiation width given by $\omega\Gamma_\gamma = 2$ eV. A

539.166 : 539.172.13

6864. Low-energy gamma radiation from the bombardment of carbon by protons. H. H. Woodbury, A. V. Tollestrup and R. B. Day. *Phys. Rev.*, **93**, 1311–14 (*March* 15, 1954).

Weak, low-energy capture radiation has been observed when C^{12} is bombarded by protons of energy 1–3 MeV. From the observed dependence of γ-ray energy on proton bombarding energy, it is

oncluded that the radiation arises from a transition o the 2·369 MeV level in N^{13}. Since the latter level is unstable to proton emission a second γ-ray is not observed. The excitation curve for this reaction shows n anomaly in the neighbourhood of 1·7 MeV, which an be explained as resulting from the interference of nonresonant p-wave radiation with the radiation rom the 3·511 MeV, $P_{\frac{3}{2}}$ level in N^{13}. A.

539.166.08 : 537.531 : 537.542

Scintillation spectrometry of continuous γ and X-ray spectra below 1 MeV. *See Abstr.* 6691

539.166.83

6865. On internal conversion with inner bremsstrahlung. K. BAUMANN AND H. ROBL. Note in *Z. Naturforsch.*, **9a**, 174 (*Feb.*, 1954) *In German.*

The differential cross-section of the final photon is calculated for a K electron and an electric multipole transition of the nucleus, the final and intermediate electrons being assumed free. P. T. MATTHEWS

539.166.835

6866. A remark on the dependence of the cross-section for pair production by photons on atomic number. B. ŚREDNIAWA. *Acta phys. Polon.*, **11**, *No.* 3–4, 331–3 (1951–52).

A calculation of the Z^4 corrections to the Bethe–Heitler formula (1934). P. T. MATTHEWS

539.166.835

6867. Gamma rays and internal pairs from $Be^9 + H^1$. R. J. MACKIN, JR. *Phys. Rev.*, **94**, 648–50 (*May* 1, 1954).

Gamma-radiation following the reaction $Be^9(p, \alpha)Li^{6*}$, resonant at $E_p = 2{\cdot}56$ MeV, has been studied with a magnetic lens spectrometer. The γ-ray energy, determined from photo- and Compton-electron spectra, is found to be $3{\cdot}572 \pm 0{\cdot}012$ MeV, not corrected for a possible 26 keV Doppler shift. The internal pair (positron) spectrum agrees most closely (to 4·5%) with the assignment of the radiation as magnetic dipole. Electric quadrupole is less likely and all other assignments are excluded. The magnetic-dipole character is consistent with the identification of the 3·57 MeV level of Li^6 as the analogue of the He^6 ground state with $J = 0^+$, $T = 1$. Reaction data are analysed to suggest that the resonant state of the compound nucleus (the 8·89 MeV level of B^{10}) has $J = 2^+$, $T = 1$. A.

539.167.3

6868. A new method for chemical separation of nuclear isomers using cyclic complex compounds. W. HERR. Note in *Z. Naturforsch.*, **9a**, 180–1 (*Feb.*, 1954) *In German.*

Rhodium phthalocyanine prepared by condensation of $Rh^{103}Cl_3$ and phthalodinitrile was exposed for 5 min to slow neutrons, heated for 2 min at 320°C with a little phthalodinitrile to recombine the recoil Rh atoms, dissolved in conc. H_2SO_4 and allowed to stand for 10 min during which the primary Rh^{104} has disappeared. Addition of water (containing $RhCl_3$ as carrier) precipitates the complex, and (partial) separation of Rh^{104m} and Rh^{104} is shown by immediate separation of the precipitate by rapid filtration and counts in a liquid counter. Half-life periods of 42 sec and 4·3 min for the ground and excited states respectively were found. It is suggested that the method could be extended to other radioelements which form stable phthalocyanine complexes, and that its value depends on the rupture of the complex as a result of the disturbance of the electron sheath by the recoil energy (relatively small and normally not large enough to break chemical bonds) of the isomeric transition. The breaking up of the complex is observed to take place only in solution. It is pointed out that in the solid state the strongly-ordered force fields will be more difficult to disturb than the force field of a dissolved molecule. W. GOOD

539.167.3

6869. Radioactive isotope separation by nuclear recoil. H. MORINAGA AND D. J. ZAFFARANO. Letter in *Phys. Rev.*, **93**, 1422 (*March* 15, 1954).

Physical separation of product nuclei in reactions such as (γ, n), (d, p) and $(\alpha, 2p)$, (no change of Z) can be achieved for light nuclei, where their recoil momenta afford a range greater than the particle diameter (e.g. in fine powder or colloidal suspension). This was verified using the $C^{12}(\gamma, n)C^{11}$ reaction in aqueous colloidal graphite (0·5% by wt.), where, with irradiation by a 70 MeV bremsstrahlung beam, 80% of the activity was found in the water phase; the reaction $Mg^{26}(\alpha, 2p)Mg^{28}$ is also suggested as suitable. A. O. STANESBY

539.167.3

6870. Elements 99 and 100 from pile-irradiated plutonium. M. H. STUDIER, P. R. FIELDS, H. DIAMOND, J. F. MECH, A. M. FRIEDMAN, P. A. SELLERS, G. PYLE, C. M. STEVENS, L. B. MAGNUSSEN AND J. R. HUIZENGA. Letter in *Phys. Rev.*, **93**, 1428 (*March* 15, 1954).

Elements with $Z > 98$ were separated by ion-exchange column. The fraction containing element 99 showed 6·64 MeV α-activity of 20 ± 2 days $\frac{1}{2}$-life (mass number 253?). Weak α-groups of about 7·2 MeV in this fraction were attributed to elements ($Z > 99$) with short $\frac{1}{2}$-life in equilibrium with 99. M. A. GRACE

539.167.3

6871. Preparation and isolation of carrier-free As^{74} from germanium cyclotron targets. M. GREEN AND J. A. KAFALAS. Letter in *J. chem. Phys.*, **22**, 760 (*April*, 1954).

The germanium target was bombarded for 6 hours with deuterons and after a period of two weeks, to allow the short-lived radionuclides to decay, it was dissolved in aqua regia. The germanium was then extracted with benzene leaving the arsenic in the acid phase. This process gave 90 ± 5% recovery and the half-life of the isolated activity was 17·5 days. P. ROTHWELL

539.169 : 548.7

6872. Creation of displacements in radiation damage. H. B. HUNTINGTON. Letter in *Phys. Rev.*, **93**, 1414 (*March* 15, 1954).

Preliminary account of a theoretical study of the formation and character of Frenkel defects in face-centred cubic metals. E. H. SONDHEIMER

NUCLEAR REACTIONS 539.17

539.172

6873. A test of charge independence by the nuclear reactions. Y. FUJIMOTO AND Y. YAMAGUCHI. Letter in *Progr. theor. Phys.*, **10**, 476 (*Oct.*, 1953).

Two pairs of nuclear reactions are quoted which, if charge independence holds, must give constant ratios of differential cross-sections, independent of angle.

G. E. BROWN

539.172

6874. Delayed decay of heavy fragments ejected from cosmic ray stars. P. CIOK, M. DANYSZ AND J. GIERULA. *Nuovo Cimento*, **11**, 436–44 (*May*, 1954).

Data concerning seven cases of production and decay of unstable nuclear fragments are compared and different interpretations discussed. In all the seven cases the unstable fragments are produced in interactions the energy of which is in the range $10–90\times10^9$ eV and which correspond to more or less central collisions of a neutral or singly charged particle with a heavy nucleus in the emulsion. The life-time of the unstable fragments is longer than 10^{-12} sec. The evaluation of the total energy released in their decay is consistent with a unique Q-value of 175 MeV, but not with the value of 140 MeV. Energy distribution among the charged secondaries shows a marked non-uniformity. In the majority of cases no mesons are observed to be emitted among these secondaries. Considering the two modes of decay of a V_1^0-particle within the nucleus: the mesonic and non-mesonic decay, all the discussed features of the seven cases support the bound V_1^0-hypothesis. A.

539.172

6875. Non-mesonic decay of a bound V_1^0-particle. W. F. FRY AND G. R. WHITE. *Nuovo Cimento*, **11**, 551–4 (*May*, 1954).

A charged nuclear fragment, ejected from a cosmic-ray star, stopped in the emulsion and subsequently disintegrated into two doubly charged particles. Both of the particles from the disintegration stopped in the emulsion. From the energies of the disintegration and the characteristics of the tracks, the fragment was found to have been $(Be^7+V_1^0)_{bound}$, or $(Be^8+V_1^0)_{bound}$, with a Q of 170 ± 3 MeV or 176 ± 3 MeV respectively. The nuclear binding of the V_1^0 was 4 ± 5 MeV or -1 ± 5 MeV respectively. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 6716–21

539.172

6876. Interactions of negative pions in carbon and lead. J. O. KESSLER AND L. M. LEDERMAN. *Phys. Rev.*, **94**, 689–702 (*May* 1, 1954).

A cloud-chamber investigation of the nuclear interactions of 125 MeV negative π-mesons has been carried out. Carbon and lead were employed as the scattering material. The experimental arrangement was designed to observe the charge-exchange process: $\pi^- + C \rightarrow B^{(exc)} + [\pi^0 \rightarrow 2\gamma]$. High-energy photons, probably attributable to charge exchange, are found to arise from nuclear interaction, with a small but finite cross-section. Total and differential cross-sections for elastic and inelastic scattering, as well as total nuclear reaction cross-sections, ar presented. A square well (optical model) analysis fit the data with a potential whose real part is attractiv and 30 MeV deep, and whose imaginary part corre sponds to a mean free path in nuclear matter o 3×10^{-13} cm. The optical model parameters ar found to be energy-dependent, the well-depth in creasing and the mean free path decreasing as th energy is raised. A.

539.172.1

6877. Measurement of angular distributions o nuclear reaction products with an internal cyclotro beam. B. L. COHEN AND R. V. NEIDIGH. *Rev. sc Instrum.*, **25**, 255–61 (*March*, 1954).

Angular distributions of elastically-scattered pro tons, and of deuterons, tritons and α-particles fro (p, d), (p, t) and (p, α) reactions are being measure with the internal 22 MeV proton beam of the Oa Ridge National Laboratory 86 in. cyclotron. The particles are detected by observing the activitie induced by them—$Cu(p, n) \rightarrow 38$ min for protons $Pb(d, p) \rightarrow 3{\cdot}3$ hr for deuterons, $Co(t, p) \rightarrow 1{\cdot}6$ h for tritons and $P(\alpha, n) \rightarrow 34$ min for α's. Energy discrimination is obtained by absorbers. The energy and energy distribution of the incident bean are found by measuring the excitation function fo $Cu(p, n)$ and comparing with published data. The angle of incidence and its inhomogeneity are deter mined by beam-locating experiments, and checked by the Rutherford law for elastic scattering from heav elements at small angles. The current is monitored by neutron counters and measured by counting the activity in the target after bombardment. This is calibrated in a separate run against the published $Cu(p, n)$ cross-section. The background is reduced (to $<5\%$ at most angles) by various types of carbon shielding. Several projects based on these methods have been carried out using the ORNL 86 in. cyclotron, and extensions to other types of measurements are in progress. A.

539.172.13

6878. Polarization by *p-p* collision at 310 MeV. J. MARSHALL, L. MARSHALL AND H. G. DE CARVALHO. Letter in *Phys. Rev.*, **93**, 1431 (*March* 15, 1954).

Polarization of $\sim60\%$, produced by scattering through 14° on a Be target, was detected by azimuthal asymmetries of up to 80% in a second Be scattering. The asymmetry as function of angle (10°–65°) was also studied when the second target was liquid H.

W. J. SWIATECKI

539.172.13

6879. Neutrons from the proton bombardment of N^{14}. F. AJZENBERG AND W. FRANZEN. *Phys. Rev.*, **94**, 409–11 (*April* 15, 1954).

The $N^{14}(p, n)O^{14}$ reaction has been investigated at 30, 60 and 150 degrees in the laboratory system by the method of proton recoils in thick nuclear emulsions. The energy of the incident protons was $17{\cdot}3\pm0{\cdot}1$ MeV, and the thickness of the melamine target was 0·2 MeV. The results indicate a ground-state Q value of $-6{\cdot}03\pm0{\cdot}2$ MeV, yielding a mass defect for O^{14} of 12·2 MeV, in good agreement with β-decay results. The data also indicate levels in O^{14} at excitation energies greater than 5·5 MeV. A.

539.172.13

(). (p, pn) and (p, αn) excitation functions. B. L. [illegible]IEN, E. NEWMAN, R. A. CHARPIE AND T. H. [illegible]NDLEY. *Phys. Rev.*, **94**, 620–5 (*May* 1, 1954).

Excitation functions for (p,pn) and $(p,\alpha n)$ reactions [illegible]e measured with the internal, 23·5 MeV proton [illegible]m of the ORNL 86 in. cyclotron. Methods of [illegible]aining homogeneous and known incident energy [illegible] described. The results indicate that, as found [illegible]viously, emission of charged particles is much [illegible]re probable than predicted by the statistical theory [illegible]nuclear reactions but that this cannot be explained, [illegible]as been proposed, by the lowering of the Coulomb [illegible]rier due to oscillations of the compound nucleus [illegible]by difficulties with the energy level density formula [illegible]ow excitation energy. A.

539.172.13

[illegible]1. Angular distributions of fission fragments from [illegible]MeV proton-induced thorium fission. B. L. COHEN, H. JONES, G. H. MCCORMICK AND B. L. FERRELL. [illegible]s. Rev.*, **94**, 625–9 (*May* 1, 1954).

The angular distributions of barium, strontium, [illegible]conium, ruthenium and silver fission products [illegible]m thorium fission induced by 22 MeV protons [illegible]re measured using the internal, circulating beam [illegible] an 86 in. cyclotron. Within the accuracy of the [illegible]asurements, all angular distributions are symmetric [illegible]out 90° and may be well fitted to $I(\theta) = a + b\cos^2\theta$. [illegible]r Ba, Sr, Zr, Ru and Ag fission products, for which [illegible] fission mass ratios are 1·53, 1·52, 1·37, 1·19 and [illegible]04, the anisotropy (b/a) is 0·26, 0·25, 0·19, 0·15 [illegible]d 0·10 respectively. A.

539.172.13

[illegible]32. Phase shift analysis of high-energy nucleon-[illegible]cleon scattering experiments. R. M. THALER AND [illegible]BENGSTON, *Phys. Rev.*, **94**, 679–82 (*May* 1, 1954).

The high-energy proton-proton scattering data are [illegible]alysed in terms of *s*-wave and *p*-wave anomalies. [illegible]fferent phase shifts are used for the three *p*-waves [illegible]th total angular momentum $j = 0, 1, 2$. It is found [illegible]at the data can be fitted without violating charge [illegible]dependence of nuclear forces. These high-energy [illegible]s vary smoothly with energy and are not in contra-[illegible]ction to the requirements of the intermediate energy [illegible]0–100 MeV) data. Inversion of nuclear levels [illegible]ggested by the shell theory of nuclear forces can [illegible]so be accounted for. A.

539.172.13

[illegible]83. Intermediate state coupling and the interpreta-[illegible]on of high-energy nucleon-nucleon scattering. R. M. [illegible]HALER, J. BENGSTON AND G. BREIT. *Phys. Rev.*, **94**, [illegible]3–9 (*May* 1, 1954).

The effect on the scattering of protons by protons [illegible] the $^3P_2 - {}^3F_2$ coupling due to an intermediate state [illegible] the two-nucleon system is investigated. The [illegible]roblem is treated in a scattering matrix formalism, [illegible]ith total angular momentum $j = 2$, orbital angular [illegible]omentum $L = j \pm 1$ and partial half-width Γ_L. [illegible]nly the $^1S_0$, $^1D_2$, $^3P_0$, $^3P_1$, $^3P_2 - {}^3F_2$ scattering [illegible]nomalies are considered. Fits to the experimental [illegible]ata at 240 MeV are studied as typical. For [illegible]$\zeta_0 \simeq 31°$, $^1K_2 > 0$ it is found that the data may be [illegible]asonably well represented provided $(\Gamma_1 + \Gamma_3)/(E_R - E) \lesssim 0{\cdot}3$. It has been found possible to fit data on *n–p* and *p–p* scattering employing phase shifts agreeing with the hypothesis of charge independence of nuclear forces. Reasonable agreement with experiment is obtained employing either the regular or the inverted order of $^3P_{0,1,2}$ levels. A.

539.172.13

6884. Theory of rearrangement collisions. Y. FUJIMOTO, S. HAYAKAWA AND K. NISHIJIMA. Letter in *Progr. theor. Phys.*, **10**, 113–14 (*July*, 1953).

A theory is described for collsions in which the incoming and outgoing particles are different, as in *d–p* and *d–n* reactions. Initial states are eigenstates of the incoming particle; final states are eigenstates of the outgoing particle. G. E. BROWN

539.172.13

6885. $(d, p\gamma)$ angular correlations and the theory of stripping. J. HOROWITZ AND A. M. L. MESSIAH. *J. Phys. Radium*, **15**, 142–4 (*March*, 1954) *In French.*

A general formula for $(d, p\gamma)$ correlations is calculated, using the theory of stripping previously presented [Abstr. 3840 (1954)], and the *P*-waves examined in detail. The form of the correlation function, and in particular its symmetry properties, depends critically on the stripping mechanism, the predictions of the Butler theory differing essentially from those in which the reaction of the scattered nucleon wave is included. P. T. MATTHEWS

539.172.13

6886. Cross-section for the processes (d, p) and (p, d). E. CLEMENTEL. Letter in *Nuovo Cimento*, **11**, 412–15 (*April*, 1954) *In Italian.*

Theoretical. The cross-sections for these re-arrangement collisions are calculated by means of the general formalism of Lippmann and Schwinger [Abstr. 8498 (1950)], using Gerjouy's simplified procedure [Abstr. 7922 (1953)]. L. PINCHERLE

539.172.13

6887. Angular correlations in the $Be^9(d, p\gamma)Be^{10}$ and $Be^9(d, \alpha\gamma)Li^7$ reactions. L. COHEN, S. S. HANNA AND C. M. CLASS. *Phys. Rev.*, **94**, 419–25 (*April* 15, 1954).

The $(d, p\gamma)$ correlation at $E_d = 0{\cdot}84$ MeV was measured under the following conditions: (1) proton direction fixed at 0° to the deuteron beam, γ-direction varying, (2) proton direction fixed at 90° to the beam, γ-direction varying in the deuteron-proton plane and (3) proton direction fixed at 90°, γ-direction varying in the 90° plane, perpendicular to the beam. The three correlations were different, and showed varying amounts of anisotropy. The appearance of terms in $\cos^4\theta$ in these correlations indicates that the spin of the first excited state of Be^{10} is $\geqslant 2$. Coupled with other information on this state, this result gives a spin assignment of 2. A qualitative discussion of the correlations is given, and the effect of the deuteron stripping process is considered. The $(d, \alpha\gamma)$ correlation was also measured with the α-direction fixed at 90° to the beam and the γ-direction varying in the deuteron-α plane. Failure to detect a departure from isotropy again confirms the assignment of $\frac{1}{2}$ to the spin of the first excited state of Li^7. A.

539.172.13

6888. Energy values for some deuteron reactions with ^{10}B, ^{11}B and ^{12}C. R. B. Elliott and D. J. Livesey. *Proc. Roy. Soc. A*, **224**, 129–33 (*June* 9, 1954).

With a 180° uniform field magnetic spectrometer, the following values for nuclear reaction energies have been obtained: $B^{10}(d, p)B^{11}$, $Q = 9{\cdot}227$ MeV; $B^{10}(d, \alpha)Be^{8}$, $Q = 17{\cdot}829$ MeV; $B^{11}(d, \alpha)Be^{9}$, $Q = 8{\cdot}029$ MeV; $B^{11}(d,\alpha)Be^{9*}$, $Q = 5{\cdot}598$ MeV; $C^{12}(d,p)C^{13}$, $Q = 2{\cdot}720$ MeV. From the $B^{11}(d, \alpha)Be^{9}$ and $B^{11}(d, \alpha)Be^{9*}$ reactions the energy of the first excited level in Be^{9} has been found to be $2{\cdot}431 \pm 0{\cdot}006$ MeV. A comparison with other results of comparable accuracy is given. A.

539.172.13 : 537.534.74

6889. Scattering of 190-MeV deuterons on protons. A. L. Bloom and O. Chamberlain. *Phys. Rev.*, **94**, 659–65 (*May* 1, 1954).

A measurement of the total *d–p* scattering cross-section is reported. Because of the divergence of Coulomb scattering at small angles, a small angle cut-off has been applied to the elastic scattering. The result may be stated as follows: The cross-section for elastic scattering to angles greater than 10° in the c.m. system, plus the total inelastic scattering cross-section is $(94^{+?}_{-?}) \times 10^{-27}$ cm^2. Measurements are also reported of those inelastic scattering processes in which both protons suffer significant momentum changes. These events are here called "inelastic *p–p* type collisions." The differential cross-sections for these events appear to be smaller than would be expected in view of the theoretical considerations of others. A.

539.172.13 : 537.534.74

6890. Elastic scattering of 190-MeV deuterons by protons. O. Chamberlain and M. O. Stern. *Phys. Rev.*, **94**, 666–76 (*May* 1, 1954).

The elastic differential scattering cross-section of 190 MeV deuterons by protons has been measured from 15° to 170° in the centre-of-mass system. The cross-sections were obtained by subtracting the carbon counts from those received with a polyethylene target. Pt I presents a description of the experiments. Pt II compares these results with those expected from theory by making use of a method developed by Chew. A summary of this comparison is given. Some nucleon-nucleon interactions involving tensor forces give reasonable agreement between theoretical and experimental results, whereas interactions involving purely central forces appear inadequate. A.

539.172.13 : 539.155.4

6891. The reaction energy of $Ne^{22}(d, p)Ne^{23}$ and the atomic mass of Ne^{23}. K. Ahnlund. *Ark. Fys.*, **7**, *Paper* 37, 459–62 (1954).

The *Q*-value was determined as $2{\cdot}968 \pm 0{\cdot}008$ MeV using deuterons of 876·5 keV and photographic detection of the single proton group whose energy was measured by magnetic deflection: this gives a value for the mass of Ne^{23} of $23{\cdot}001763 \pm 0{\cdot}000027$ a.m.u. M. A. Grace

539.172.13 : 778.34

6892. Nomograms for the simplification of calculations referring to the energy of neutrons in (*d*, *n*) reactions. J. Catalá, J. Aguilar and F. Sene[illegible] *An. Real Soc. Españ. Fis. Quím.*, **50(A)**, 33–40 (*Ja[illegible] Feb.*, 1954) *In Spanish.*

Three nomograms are given for simplify[illegible] calculations made on measurements of proton tra[illegible] produced by neutrons in nuclear emulsions. Ti[illegible] can be saved by their use and there is no apprecia[illegible] loss of accuracy.

539.17[illegible]

6893. Photonuclear reactions. A. I. Berm[illegible] *Amer. J. Phys.*, **22**, 277–90 (*May*, 1954).

The significant aspects of photonuclear proces[illegible] are reviewed in terms of the trends in research si[illegible] their discovery in 1934. Experimental techniques w[illegible] high-energy X-radiation, which are currently emplo[illegible] in these investigations, are described.

539.17[illegible]

6894. The photo-disintegration of beryllium by high energy gamma-rays. B. Arakatsu, M. Sono[illegible] Y. Uemura, S. Yasumi and Y. Saji. *Mem. C[illegible] Sci. Univ. Kyoto A*, **26**, 97–107 (*Oct.*, 1950).

A proportional counter, internally coated with [illegible] was irradiated with (Li + *p*) and (F + *p*) *γ*-ra[illegible] For (Li + *p*) *γ*-rays, the pulse-height distribut[illegible] obtained is consistent with *α*-particles from [illegible] $Be^{9}(\gamma, n)Be^{8}(2\alpha)$ reaction, involving the ground-st[illegible] and 7 MeV level of Be^{8} (cross-sections 51 mb a[illegible] 2·15 mb respectively). For (F + *p*) *γ*-rays, part [illegible] the pulse-height distribution is attributable to [illegible] Be^{8} ground-state reaction (cross-section 1·62 mb)[illegible] J. J. Wilk[illegible]

539.17[illegible]

6895. Angular distribution of the deuteron pho[illegible] disintegration at moderate energies. A. Sugie a[illegible] S. Yoshida. Letter in *Progr. theor. Phys.*, **10**, 23[illegible] (*Aug.*, 1953).

It is shown that the comparatively large isotro[illegible] part of the differential cross-section in the ener[illegible] region of 10–20 MeV cannot be accounted for by [illegible] exchange moment alone. G. Fie[illegible]

539.172[illegible]

6896. The $Mg^{24}(\gamma,3p3n)F^{18}$ reaction induced 70-MeV bremsstrahlung. F. D. Schupp and D. Martin, Jr. *Phys. Rev.*, **94**, 80 (*April* 1, 1954).

F^{18} was identified among the products of irradiation of Mg by 70 MeV bremsstrahlung means of its chemical and radioactive properti[illegible] Considering the F^{18} to be formed solely by the loss [illegible] six nucleons from Mg^{24}, the yield of the proc[illegible] $Mg^{24} + \gamma \rightarrow F^{18}$ was 0·042 on the basis of unity fl[illegible] $N^{14} + \gamma \rightarrow N^{13} + n$. Preliminary experiments ha[illegible] indicated that 70 MeV bremsstrahlung gives t[illegible] processes $Ca^{40} + \gamma \rightarrow Cl^{34}$ and $Cl^{35,37} + \gamma \rightarrow Si^{31}$.

539.172[illegible]

6897. Measurement of the nuclear rays [neutr[illegible] cross-sections] of certain elements. M. Ageno, [illegible] Cortellessa and R. Querzoli. *R.C. Ist. Supe[illegible] Sanità*, **16**, *Pt I–II–III*, 21–7 (1953) *In Italian.*

By the use of a method described in Abstr. 36[illegible] (1953), the total cross-section for 14 MeV neutrons [illegible] the elements Al, O, P, S, Cu, Au, Hg, Pb and Bi w[illegible] determined under good geometric conditions and t[illegible] effective nuclear radii deduced. No systema[illegible]

viation from the known laws of linear dependence
nuclear radii from the cube root of the mass
nber was noted and so the authors conclude that,
hin the limits of accuracy of the measurements
), Feshbach and Weisskopf's statistical theory is
accord with the experimental results. A.

539.172.4

98. Cross sections for the $O^{16}(n, p)N^{16}$ reaction m 12 to 18 MeV. H. C. MARTIN. *Phys. Rev.*, **93**, 8–9 (*Feb.* 1, 1954).

The energy dependence of the $O^{16}(n, p)N^{16}$ reaction oss-section has been determined for neutron energies m 12 to 18 MeV. For 14 MeV neutrons, the solute value of the reaction cross-section was found be 89 ± 30 mb. A.

539.172.4

99. Pile production of radioisotopes by threshold actions. D. J. HUGHES. Letter in *Nature* [*London*] **3**, 396 (*Feb.* 27, 1954).

It is shown that the effective cross-sections for p) and (n, α) reactions can be satisfactorily edicted. J. M. CASSELS

539.172.4

00. The $Li^7(n, t)$ reaction. R. L. MACKLIN AND E. BANTA. *Science*, **119**, 350–1 (*March* 12, 1954).

The cross-section, measured by activation methods, is found to be 72 ± 18 mb at about 3 MeV neutron ergy, and 30 ± 20 mb at about 4·5 MeV.

J. M. CASSELS

539.172.4

01. Slow neutron resonances in europium. V. L. AILOR, H. H. LANDON AND H. L. FOOTE, JR. *Phys. ev.*, **93**, 1292–6 (*March* 15, 1954).

The total cross-section of europium has been easured over a range of neutron energy from 0·08 58 eV. Resonances occur at 0·327, 0·461, 1·055, 76, 2·46, 2·73, 3·35, 3·84, 6·25, 7·36 and 8·98 eV. etween 10 and 20 eV resonances were found at 0·6, 11·8, 12·8, 15·1 and ~ 19·5; however, it is robable that several additional resonances were resent but not observed because of insufficient in- rument resolution. Many resonances are present bove 20 eV which could not be resolved. The rength, $\sigma_0\Gamma^2$, and various other Breit–Wigner para- eters have been obtained for the resonances below 0 eV. The ratio of the average reduced neutron idth to the average level spacing, Γ_n^0/D, was found be $3·5\times10^{-4}$ for Eu^{151} and $3·3\times10^{-4}$ for Eu^{153}.

A.

539.172.4

02. Plutonium-244 from pile-irradiated plutonium. H. STUDIER, P. R. FIELDS, P. H. SELLERS, A. M. FRIEDMAN, C. M. STEVENS, J. F. MECH, H. DIAMOND, SEDLET AND J. R. HUIZENGA. Letter in *Phys. Rev.*, **3**, 1433 (*March* 15, 1954).

Successive neutron captures in Pu^{239} using an inte- rated flux of 4×10^{21} neutrons leads to Pu isotopes f mass numbers 240, 241, 242 and 244, identified by ass spectrometer; the yield of Pu^{244} was $3·6\times10^{-5}$ hat of Pu^{242}. A value for the (n, γ) cross-section of Pu^{242} of 30 ± 10 barns is given. M. A. GRACE

539.172.4

03. Scattering of fast neutrons in light nuclei. C. F. COOK AND T. W. BONNER. *Phys. Rev.*, **94**, 651–3 (*May* 1, 1954).

The total cross-section of hydrogen, deuterium, lithium, beryllium, boron 10, boron 11, carbon, oxygen, magnesium, aluminium and sulphur have been measured for neutrons whose energies were varied from 14–18 MeV. All elements except carbon exhibit a decrease in cross-section with increasing energy. Carbon exhibits a broad resonance at 16 MeV neutron energy. Nuclear radii calculated from these cross-sections have the following values in units of 10^{-13} cm: Li—3·29, Be^9—3·51, B^{10}—3·56, B^{11}—3·49, C^{12}—3·41, O^{16}—3·85, Mg—4·04, Al—3·98 and S—4·33. The n–p and n–d cross-sections are compared with the theoretical calculations.

A.

539.172.4

04. An interpretation of asymmetric fission. T. SASAKAWA AND T. SAWADA. Letter in *Progr. theor. Phys.*, **10**, 585–7 (*Nov.*, 1953).

Some features of the oscillations of an "ocean" covering a solid core are discussed. Such a core would be responsible for the asymmetry of nuclear fission at low energies, symmetry appearing at higher energies with the "melting" of the core.

W. J. SWIATECKI

539.172.4 : 537.214

05. Coulomb energy of a uniformly charged liquid-drop. II. O. MIYATAKE. *J. Inst. Polytech. Osaka City Univ. B*, **3**, 67–70 (*Oct.*, 1952).

For Pt I, see Abstr. 3869 (1954). The method is similar to that used to derive an approximate solution of a differential equation by subdividing the interval of the independent variable and calculating the value of the unknown function successively at each point.

A. E. KAY

539.172.4 : 537.214

06. Coulomb energy of a uniformly charged liquid-drop. III. O. MIYATAKE. *J. Inst. Polytech. Osaka City Univ. B*, **3**, 71–7 (*Oct.*, 1952).

Buehler and Hirschfelder's bipolar expansion of Coulomb potentials [Abstr. 7530 (1951)] is used.

A. E. KAY

539.172.4

07. Angular distribution of fragments from neutron-induced fission. J. E. BROLLEY, JR AND W. C. DICKINSON. *Phys. Rev.*, **94**, 640–2 (*May* 1, 1954).

A parallel-plate ionization chamber, in which one electrode served as a collimator, was employed to study the angular distribution of fission fragments referred to the neutron beam axis. Fragments from neutron bombardment of the following nuclei were examined: Th^{232}, U^{233}, U^{235}, U^{238} and Np^{237}. When 14 MeV neutrons were used, a preponderance of fission along the neutron axis as compared with the orthogonal direction was noted. The average value obtained for the 0°/90° ratios was 1·26. Thermal neutron fission was found to be isotropic. A.

539.172.4

08. Safeguard considerations for nuclear power plants. H. HURWITZ, JR. *Nucleonics*, **12**, 57–61 (*March*, 1954).

An attempted analysis of the magnitude of the

energy released in explosions of nuclear power plants, as a result of malfunction and failure of all safety devices, is outlined. It is concluded that the explosions would be no more energetic than those produced by small amounts of chemical explosives. The main hazard would result from the release of fission products, but containment of these in gas-tight buildings should be possible. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

6909. Observation of the stopping of heavy mesons. A. ALIKHANYAN, V. KIRILLOV-UGRYUMOV, N. SHOSTAKOVICH, V. FEDOROV AND G. MERZON. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 5, 915–17 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-214.

Discusses five examples of heavy mesons stopping in a multiplate chamber placed at the exit of a magnetic spectrometer. The first is positively charged and three particles emerge from the stopping point. Its mass is estimated to be 990 m_e and it is probably a τ-meson. In the second case the primary is negative and on stopping gives rise to a single secondary at minimum ionization. The mass of the primary is estimated to be 940 $\pm$ 90 m_e. Two other cases were observed in which negative mesons with masses $\sim$ 1000 m_e stopped and the secondary particles were either π- or μ-mesons. The fifth example is a positive primary of mass 1520 $\pm$ 150 m_e which gives rise to a single secondary and may be a χ-meson. H. ELLIOT

539.18

6910. Negative π–μ meson decays in photographic emulsion. W. F. FRY AND G. R. WHITE. Letter in *Phys. Rev.*, **93**, 1427 (*March* 15, 1954).

Among 40 000 slow negative-π endings 18 π–μ decays were observed (of these 6 were π–μ–e). A range histogram suggests the decay of the π's from negative energy state of average momentum 3·3 MeV. W. J. SWIATECKI

539.18

6911. An analysis of two positive τ-mesons. A. DEBENEDETTI, C. M. GARELLI, G. LOVERA, L. TALLONE AND M. VIGONE. Letter in *Nuovo Cimento*, **11**, 420–3 (*April*, 1954).

The two τ-mesons were observed to decay in stacks of nuclear emulsion and in each case the positive π-mesons decayed in the emulsion and the negative π-mesons stopped without producing a star. Values of mass and Q values are given. H. ELLIOT

539.18

6912. Four τ-mesons observed on Kilimanjaro. K. R. DIXIT. *Z. Naturforsch*, **9a**, 355–7 (*April*, 1954).

Four τ-meson-events observed on the top of Mount Kilimanjaro are described. Two of them definitely show that a τ-meson can disintegrate into two π-mesons and one μ-meson. The third event also indicates the same possibility, whereas no definite conclusion can be drawn from the fourth event. The mean mass of the τ-meson comes out as 959 $\pm$ electron masses.

539.

6913. A study of τ-meson decay. E. FABRI. *Nuo Cimento*, **11**, 479–91 (*May*, 1954).

The distribution of the π-mesons in the decay of t τ-meson is studied, and approximate expressions f the matrix elements are found. Thus one can justi Dalitz's results [Abstr. 8702 (1953)], in which t relativistic corrections are also introduced. T comparison with experiment is made taking in account the charges of the π-mesons; the experimen data, however, are still too scarce to give any inform tion about parity and spin of the τ-meson.

539.

6914. Decay of a heavy nuclear fragment. P. FREIER, G. W. ANDERSON AND J. E. NAUGLE. *Ph Rev.*, **94**, 677–8 (*May* 1, 1954).

Possible explanations of a three-prong star at t end of a stopping heavy fragment are considere The event can be tentatively explained in terms of t non-mesonic decay of a V_1^0 particle attached to t fragment.

539.

6915. Total interaction cross section of pions wi protons and deuterons at 1·0 BeV. R. L. COOL MADANSKY AND O. PICCIONI. Letter in *Phys. Re* **93**, 637–8 (*Feb.* 1, 1954).

Using the method of Abstr. 4983 (1954), $\sigma(\pi^-$, was found to be 48 $\pm$ 4 mb and $\sigma(\pi^-, d$–$p) = 21 \pm$ mb. Comparison with measurements of $\sigma(\pi^-, p)$ 450, 850, 1500 MeV suggests a maximum at $\sim$ 1 Be W. J. SWIATEC

539.

6916. The existence of unstable charged partic with mass exceeding the mass of a proton. A. ALI HANYAN, V. KIRILLOV-UGRYUMOV, N. SHOST KOVICH, V. FEDOROV AND G. MERZON. *Dokl. Aka Nauk SSSR*, **92**, *No.* 4, 719–21 (1953) *In Russia* English translation, *U.S. National Sci. Found. NS tr*-204.

Discusses two photographs, taken with the co bined magnetic spectrometer and multi-plate clo chamber, in which positively charged particles mass 2230 $\pm$ 150 m_e and 2250 m_e are observed decay, giving a fast secondary. From the dimensio of the apparatus it is concluded that the lifetime of t heavy particles cannot be much less than 5×10^{-9} s H. ELLI

539.

6917. The magnetic mass-spectrometer in co bination with a Wilson cloud chamber. A. ALI HANYAN, V. KIRILLOV-UGRYUMOV, N. SHOSTAKOVI AND V. FEDOROV. *Dokl. Akad. Nauk SSSR*, 9 *No.* 2, 255–7 (1953) *In Russian.* English translatio *U.S. National Sci. Found. NSF-tr*-182.

The magnetic spectrometer has been used conjunction with a multi-plate cloud chamber to gi range and momentum measurements, and hence ma estimates, for mesons. Details of the experiment arrangement are given and it is stated that in additi to π- and μ-mesons particles of mass 500 to 600 and 900 to 1200 m_e have been observed. H. ELLI

539.18

8. Fermi's thermodynamic theory of the pro-tion of pions. D. S. KOTHARI. Letter in *Nature ndon*] **173,** 590 (*March* 27, 1954).

t is shown that, because of the Lorentz contraction, mi's expression, in which a sum is replaced by an egral, seriously underestimates the total number of ns produced [see Abstr. 3336 (1951)].

W. J. SWIATECKI

539.18

19. Production of *K* mesons. U. HABER-SCHAIM, YEIVIN AND G. YEKUTIELI. *Phys. Rev.*, **94,** 184–5 *pril* 1, 1954).

Calculations reported in Abstr. 1929 (1953) are ended to lower energies using Fermi's explicit tistical method. A few pertinent details of the culation are given, and the results compared with observations of the Bristol group. A.

539.18 : 539.172.3

20. A connection between pion photoproduction d scattering phase shifts. M. ROSS. *Phys. Rev.*, **94,** 4–60 (*April* 15, 1954).

It is found in a rough approximation that meson otoproduction matrix elements can be expressed in rms of meson-nucleon scattering phase shifts and me energy-independent parameters, for photons in e laboratory of 200 to 500 MeV. The parameters e fitted to experiment in the lower portion of this ergy region. It is then found that the higher-energy otoproduction data is consistent only with a $p_{\frac{3}{2}}$, otopic spin $\frac{3}{2}$, phase shift which passes through 90° a scattering energy of about 180 MeV. It is dicated that the *s*-wave phase shifts remain small.

A.

539.18

21. On charge independence in the production of particles. R. GATTO. *Nuovo Cimento*, **11,** 445–57 *May*, 1954) *In Italian.*

Discusses the implications of the hypothesis of harge independence applied to simple processes of roduction of Λ-particles, some of which have been ecently observed. For completeness the decay rocesses of the particles involved are discussed, hough the applicability of the charge independence ypothesis in this case may appear far less secure. ssuming half integral isotopic-spin for the Λ-particles, hen to any production process of Λ^0-particles there orresponds a production process of Λ^+-particles, aving the same cross-section. Supposing, moreover, harge independence to hold, it can be shown that he cross-sections for the production of Λ^0- (and Λ^+-) particles can be severely limited in terms of the cross-ection for the production of Λ^{++} (or Λ^-). Assuming ntegral isotopic spin for the Λ-particles (Gell-Mann) t can still be shown that the cross-section for the roduction of Λ^0-particles can be severely limited in terms of the cross-section for the production of Λ^- (or Λ^+). On the other hand the Gell-Mann hypothesis, with a few reasonable assumptions, only allows the contemporary production of the same number ("number" meaning the difference between the number of particles and the number of antiparticles) of new fermions and new bosons, a prediction that should be capable of experimental verification. The particular relations and inequalities among the differential (and total) cross-sections, which result from the assumption of charge independence for the various assignments of isotopic spins, are given. A.

539.18

6922. Multiple production of mesons with pseudo-scalar coupling. W. THIRRING. *Helv. phys. Acta*, **27,** *No.* 1, 45–56 (1954) *In German.*

Using Feynman's method and treating the nucleon classically, the probabilities for the production of 1, 2, 3 mesons at 2 GeV are found to be in the ratios 1 : 0·5 : 0·01. The relatively large probability for the production of even numbers of mesons is characteristic of pseudoscalar coupling.

W. J. SWIATECKI

539.18

6923. On the pion-nucleon scattering. Y. MIYACHI. Letter in *Progr. theor. Phys.*, **9,** 469–70 (*April*, 1953).

A non-local Lagrangian in symmetrical theory is used for the calculation of cross-sections. The parameters are fitted to make the results agree with experimental values for π^+-p scattering. The combined total cross-section for elastic and inelastic π^--p scattering then comes out to be larger than the experimental value. G. FIELD

539.18

6924. Some comments on the theory of *V*-particle. K. ONO. Letter in *Progr. theor. Phys.*, **10,** 111 (*July*, 1953).

It is argued that the large number ($\sim 10^{10}$) of internal states of the V^0 [Abstr. 3878 (1954)] should not be interpreted in terms of a composite nature of the *V*-particle. W. J. SWIATECKI

539.18

6925. Charge independence for *V*-particles. T. NAKANO AND K. NISHIJIMA. Letter in *Progr. theor. Phys.*, **10,** 581–2 (*Nov.*, 1953).

Some conservation and selection rules following from the above assumption are discussed.

W. J. SWIATECKI

539.181

6926. Scattering of high-velocity neutral particles. II. Helium-helium. I. AMDUR AND A. L. HARKNESS. *J. chem. Phys.*, **22,** 664–9 (*April*, 1954).

For Pt I, see Abstr. 7291 (1949). Total collision cross-sections have been measured for helium atoms, with energies between 500 and 2100 eV, scattered in room temperature helium. Measurements were made with two detectors of different geometric aperture, 13·4 and 0·96 min. In order to obtain meaningful potential energy information from such results, it is necessary to determine effective apertures by taking into account beam shape, intensity distribution, and for the case where the beam is wider than the detector, scattering to the detector from external regions of the beam. Potential energy functions have been derived from the cross-sections obtained with the two detectors. The functions agree within a factor of about 1·3 as compared with 0·17 when geometric apertures are used directly. The results from both detectors have been represented by an average function, namely, $V(r) = 7{\cdot}55 \times 10^{-12}/r^{5{\cdot}94}$ ergs for values of r between 1·27 Å and 1·59 Å. The potential energy information

obtained from the present experiments is in agreement with theoretical calculations of P. Rosen and Margenau within the uncertainty of such calculations. The information also appears to be consistent with that derived from measurements of gaseous compressibility and viscosity, for values of r between 1·90 Å and 2·30 Å. A.

539.181

6927. Scattering of high-velocity neutral particles. III. Argon-argon. I. Amdur and E. A. Mason. *J. chem. Phys.*, **22**, 670–1 (*April*, 1954).

Total collision cross-sections have been measured for argon atoms, with energies between 700 and 2100 eV, scattered in room-temperature argon. Results obtained with two detectors of different geometric aperture are shown to be in accord when allowance is made for beam shape, intensity distribution, and scattering to a detector which is narrower than the beam, in accordance with procedures previously used for helium scattered in helium. Potential energy information derived from the cross-sections may be represented by $V(r) = 1{\cdot}36\times10^{-9}/r^{8{\cdot}33}$ ergs for values of r between 2·18 Å and 2·69 Å, and appears to be consistent with that derived from measurements of gaseous compressibility, viscosity and crystal properties. A.

539.185

6928. Sources of neutrons for experimental purposes. J. E. Sanders. *Atomics* [*London*] **5**, 78–82 (*March*, 1954).

A general review with appropriate numerical data. J. M. CASSELS

539.185

6929. The influence of hindered rotation on the scattering of slow neutrons by bound protons. W. Kołos. *Acta phys. Polon.*, **13**, *No.* 1, 67–75 (1954).

The cross-section of the proton bound in a molecule which has an additional degree of torsional freedom is calculated. It is shown that the cross-section of the proton for the collisions which are elastic with respect to the hindered internal rotation but exciting the rotation of the whole molecule about the axis of the hindered rotation, is smaller than that of a proton bound in a rigid molecule. It follows from the theory that the lowering of the cross-section depends on the energy of the incident neutrons and on the thermal energy of the scattering molecules. A.

539.185

6930. Neutron-proton scattering with spin-orbit coupling. II. Variational formulation and effective range theory. L. C. Biedenharn and J. M. Blatt. *Phys. Rev.*, **93**, 1387–94 (*March* 15, 1954).

For Pt I, see Abstr. 5342 (1952). The variational methods of Schwinger *et al.* are used to give variationally correct expressions for the three independent real parameters in the scattering matrix ($\delta_{J\alpha}$, $\delta_{J\beta}$ and ε_J) for the "mixed" states, such as ${}^3S_1 + {}^3D_1$, of the neutron-proton system with spin-orbit coupling. The relation between these variational principles and the effective range theory is discussed briefly. The effective range expansions are then derived non-variationally. The two leading terms are given for $k^5 \cot \delta_{1\beta}$ and for $k^{-2} \tan \varepsilon_1$. The three leading terms are given for $k \cot \delta_{1\alpha}$. A.

539.1

6931. Estimating differential scattering cross sectio in gases. T. Ahrens. *J. appl. Phys.*, **25**, 505 (*April*, 1954).

A simple method of estimating differential angul scattering cross-sections in an infinite medium presented. It assumes that single-scattering theo approximates the radiation flux at a detector which separated from the source by much less than a me free path.

539.185.

6932. Measure of the absolute intensity of a neutr source. E. Rodríguez Mayquez and C. Sánch del Río. *An. Real Soc. Espań. Fis. Quím.*, **50**(27–32 (*Jan.–Feb.*, 1954) *In Spanish.*

The Ra–Be neutron source contained 500 mg radium plus 5 g beryllium and produced (5·85 0·76)×10^6 neutrons/sec. The experimental procedu is described and the result discussed and compar with those of similar determinations.

539.185.08 : 778.

Boron-loaded photographic plates as detectors slow neutrons. *See Abstr.* 7062

STRUCTURE OF SOLIDS 539.2

539.213

6933. Physics of the glassy state. III. Strength glass. E. U. Condon. *Amer. J. Phys.*, **22**, 224– (*April*, 1954).

For Pt II, see Abstr. 5012 (1954). The ma empirical facts about the strength of glass are reviewe including statistical theories, effects of adsorbe moisture and of acid treatments.

539.213

6934. Physics of the glassy state. IV. Radiatio sensitive glasses. E. U. Condon. *Amer. J. Phys* **22**, 310–17 (*May*, 1954).

Effects of radiation in producing colour change often called solarization, in glass are described, close analogy with modern work on *F*-centr especially in alkali-halide crystals. Photosensitiv glasses in which the action of radiation is to produ centres of nucleation around which colloidal crystalline precipitates can form are also discussed.

539.234 : 548.7

The structure of thin layers of alkali halide evaporated on single crystal substrates. *See Abst* 7045

539.26 : 539.4.01

6935. "Mean strains" in worked aluminium P. Gay and A. Kelly. *Acta Cryst.*, **7**, 333–6 (*April* 1954).

Experiments have been carried out to investigat the cause of the relative radial displacements o adjacent diffraction spots on some X-ray microbeam back-reflection photographs of rolled polycrystallin aluminium. Among other causes, it is possible tha the displacements are due to the existence, within th material, of particles in which the lattice spacing i

fferent from the average value. From the present periments it is concluded that a few reflections from ch particles have been found. The stresses required produce strains of the observed magnitude are of e order of the yield stress of the material. A.

539.27

936. Preparation of films by a mercury technique r use in the electron microscope. J. LEROUX. *Rech. Cent. Nat. Rech. Sci.*, **5**, 259–60 (*Dec.*, 1953) *French.*

A method for the preparation of strong thin plastic lms for supporting electron microscope specimens is escribed. A drop from a dilute solution of collodion n amyl acetate is allowed to spread on mercury in a pecially designed trough. The film, after evaporation f the solvent, is lifted from the mercury by water ntroduced through the bottom of the trough. It is laimed that the high surface tension of the mercury eads to the formation of extra strong films.

M. E. HAINE

539.27

6937. A combination of electron microscopy and liffraction. S. YAMAGUCHI. *J. Sci. Res. Inst. Tokyo*] **47**, 202–4 (*Dec.*, 1953).

A method for re-setting the high voltage supply of an electron microscope to a standard value is described. An electron diffraction camera is used in parallel with the microscope, and a diffraction ring diameter used as a measure of the voltage. It is claimed that "blind" focusing of the microscope can be achieved by this method. M. E. HAINE

539.27

6938. Summarized proceedings of a conference on electron microscopy—London, November 1953. C. E. CHALLICE. *Brit. J. appl. Phys.*, **5**, 165–70 (*May*, 1954).

Brief summaries are given of papers read at the annual conference of the Electron Microscopy Group of The Institute of Physics. Subjects include: Electron optics; Chemical applications; Applications of the grazing incidence microscope; Replica techniques.

539.27 : 548.74

6939. Study of thin crystalline films by universal electron diffraction microscope. H. HASHIMOTO. *J. Phys. Soc. Japan*, **9**, 150–61 (*March–April*, 1954).

In ordinary electron micrographs of MoO_3 crystals and mica films, which were obtained by using a universal electron diffraction microscope as an ordinary electron microscope unit, there were observed the well-known patterns which may be called "a group of closed contours," "dark spots" and "feather-like patterns," and some patterns were also observed which may be called "wave-like patterns." These patterns could be analysed by using the universal electron diffraction microscope as a shadow microscope unit and high-resolution electron diffraction camera. In the high-resolution electron diffraction patterns and in the diffracted parts of shadow micrographs of bent films of the crystals, obtained by the universal electron diffraction microscope, subsidiary maxima were observed which correspond to the intensity region in the reciprocal lattice extended in the direction normal to the film surface; and from the angular distances of the subsidiary maxima, the thickness of the film, the Fourier coefficient of periodic electric field in the crystal and the external form of bent film could be obtained. Takagi and König observed that the MoO_3 crystal transforms into minute MoO_2 crystals when it is irradiated by an intense electron beam. Besides the transformation of MoO_3 to MoO_2, another type of transformation $MoO_3 \rightarrow MoO_2' \rightarrow MoO_2$ was observed. The intermediate substance MoO_2' is observed as homogeneous in ordinary electron micrographs. By using the universal electron diffraction microscope as a micro-diffraction unit, it has been possible to show that the intermediate substance belongs to the monoclinic system and that some hexagonal holes produced in it are bounded by its net planes. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32 : 534.213

6940. Generalization of an electrostatic method for the ultrasonic measurement of elastic and anelastic constants of solids. P. G. BORDONI AND M. NUOVO. *Acustica*, **4**, *No.* 1, 184–7 (1954) *In French.*

Paper given at the Congress of the International Commission of Acoustics, Netherlands, 1953. Improvements are described in an electrostatic method for measuring the elastic and anelastic constants of solids by means of longitudinal and torsional vibrations up to frequencies of 300 kc/s. A.

539.32 : 537.228.1

Dynamic determination of elastic constants. *See Abstr.* 6593

539.373 : 548.7

6941. The formation of cracks as a result of plastic flow. A. N. STROH. *Proc. Roy. Soc. A*, **223**, 404–14 (*May* 6, 1954).

The stresses round a piled-up group of dislocations are investigated with reference to the initiation of a crack. A crack should form when the group consists of about 1000 dislocations piled up under a stress of the magnitude occurring in a cold-worked metal. The stress system due to the crack is obtained. The crack will have a stable equilibrium length, but this length is likely to be determined by the amount of plastic flow which takes place round the tip of the crack. A.

539.374

6942. Some data on the relation of relaxation and rate characteristics in plastic deformation. L. I. VASIL'EV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 3, 451–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-33.*

From stress-relaxation data for annealed wires of Sn, Cu, Ni and a Cu–Ni alloy, a coefficient of weakening—defined as the proportional rate of relaxation of stress at constant elongation—is plotted against the elongation. From plastic-flow experiments at constant rates of elongation, the proportional increase in stress due to a certain increase in rate is

plotted against the elongation. There is a clear correspondence between the two plots for all four metals.

J. G. OLDROYD

539.374

6943. On the correspondence between relaxation and rate characteristics in plastic extension. L. I. VASIL'EV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 2, 301–2 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-195.

Continuation of previous work (preceding abstract). Further evidence of the close qualitative correspondence between relaxation rate and rate of plastic flow is obtained from experiments with annealed wires of Sn, Al, Cu, Ni and a Cu–Ni alloy. J. G. OLDROYD

539.374

6944. Bauschinger effect by torsion of copper wires. M. J. DRUYVESTEYN AND C. F. ETIENNE. *Appl. sci. Res. A*, **4**, *No.* 2, 100–4 (1953).

The Bauschinger Effect (B.E.) varies with the amount of torsional deformation in the manner calculated by Rahlfs and Masing [*Zeitschrift für Metallkunde*, **41**, 454 (1950)] at 20°C, but is larger than expected at −180°C. The B.E. is constant for temperatures up to −40°C, decreases from −40 to +20°C, and remains constant for $T > +20$°C. This reveals a change in the mechanism responsible and since it occurs in that range of T where is found a recovery of the increased resistance of copper produced by cold work [Abstr. 5361 (1952)], it may be associated with the relief of stress by vacancy migration The B.E. is insensitive at −190°C to the amount S of preliminary stretching of the wire, but at +20°C decreases with S from $S = 1$ to 4% and is then constant for larger S. A. D. LE CLAIRE

539.374

6945. The viscoelastic properties of plastics. F. BUECHE. *J. chem. Phys.*, **22**, 603–9 (*April*, 1954).

A general method has been devised to predict the viscoelastic behaviour of plastics. A simplified model of the molecule is assumed and its general motion is treated by the method of normal co-ordinates. General equations have been developed such that when the manner of application of external forces to the molecule is known, the molecule's general behaviour may be found in a convenient and straightforward fashion. This method has been used to obtain theoretical curves for the viscoelastic behaviour of cross-linked polymers subjected to sinusoidal forces. Also, the similar problem for linear material has been solved together with the creep and stress relaxation problems. It is shown that the temperature-time superposition procedure of Ferry and Tobolsky has a firm theoretical basis. In general, the theoretical curves appear to agree with the limited experimental data available. The method is also applied to the case of dilute solutions and comparison is made with the result obtained by Rouse using a different approach. A.

539.374 : 534.012

6946. Propagation of longitudinal deformation waves in a prestressed rod of material exhibiting a strain-rate effect. R. J. RUBIN. *J. appl. Phys.*, **25**, 528–36 (*April*, 1954).

The longitudinal propagation of stresses above the yield stress in a material exhibiting a strain-rate effect is considered. The system consists of a semi-infinite rod subjected to end impact. If the rod is prestressed above the yield point and if the impact stress is not too large, the equations of motion are linear. Integral representations of the solutions can be obtained by the method of Laplace transforms. It is shown in general that the strain-rate solutions approach asymptotically the solutions obtained by von Kármán and Taylor in a treatment which neglects the strain-rate effect. The propagation of the unloading wave is considered for the case in which the initial wave is a shock wave. The condition which defines the region in the x–t plane, where the loading and unloading equations apply, is given. It is shown that an unloading shock wave will be absorbed except for the case of a material which does not work-harden. In this case the complete solution of the unloading problem is obtained.

539.38

6947. Dependence of the compressibility of the elements on their atomic number. L. F. VERESHCHAGIN AND A. I. LIKHTER. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 4, 745–7 (1952) *In Russian.*

Calculates from available data, and graphs, the compressibility of 30 elements at 100 000 kg/cm² and of 50 elements at 30 000 kg/cm², plotted against their atomic numbers. The periodicity is preserved even at 100 000 kg/cm². The compressibility range (ratio of largest to least compressibility) decreases from 1 to 100 000 kg/cm², being 310 at 1, 36 at 30 000, and 9 at 100 000 kg/cm², the least compressible element being always C (diamond), and the most compressible Cs (at 1 and 30 000 kg/cm²) and Ba (at 100 000 kg/cm²). The alkali metals are the most compressible at 1 and 30 000 kg/cm², while the alkaline earth metals occupy peak values at 100 000 kg/cm². The polymorphic transition of Cs at 45 000 kg/cm², accompanied by a volume change of 5·6%, is probably due to the transition of a 6*s* electron to the 5*d* level. The alkaline earth metals show a much smaller volume change at very high pressures. F. LACHMA

539.5

6948. Hardness of metals and alloys. G. B. CHATTERJEE. *Indian J. Phys.*, **28**, 9–20 (*Jan.*, 1954).

While tensile strength and other mechanical or physical properties of metals and alloys can be well defined and expressed in terms of the fundamental units of mass, length and time, it is difficult to define hardness and express it in terms of those units. An attempt has been made in this paper to define hardness H as the work done per unit volume of indentation in a static ball indentation test. On this basis and on the basis of Meyer's law, $L = ad^n$, where L is the load, d is the diameter of indentation and a and n are constants, it has been found that $H = (pe^{\beta n})/[2 - \cos\theta(\sin^2\theta + 2)]$ where p and β are constants and θ is the angle of indentation. For a given value of θ it is shown that H may be expressed by the simple equation $H = af_n$ where the factor f is a known function of n. Thus the determination of H merely involves the determination of the values of a and n. The values of H expressed as Kg.mm/mm² compares well with those of the Brinell hardness

mber H_B for different metals and alloys under ferent treatments. Considering the completely ferent approach to the concept of hardness H and e different method adopted in measuring H, the reement between H and H_B values appears to be ite satisfactory. The advantages and limitations the method are also indicated. A.

539.62

.49. On the effect of normal load on the frictional rce in mixed boundary-hydrodynamic lubrication. . M. Tolstoĭ. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 5, 9–22 (1953) *In Russian.*

Deryagin's theory for the normal reaction between ding surfaces under boundary lubricating conditions as been modified for surfaces where the roughness d speed of sliding lead to mixed boundary and drodynamic conditions. Two extra terms are troduced to account for the parts of the load supported by hydrostatic compression of liquid trapped tween surface asperities and by the wedging pressure of liquid flowing in small channels between perities. The effect of these additional terms is nsidered for a number of surface geometries and bricants. J. W. MENTER

539.62

950. The influence of oxide and lubricant films on e friction and surface damage of metals. W. Hirst nd J. K. Lancaster. *Proc. Roy. Soc. A*, **223**, 324–38 *May* 6, 1954).

It is shown that the protection against surface mage afforded by an oxide film during the sliding two metal surfaces depends on the geometrical iding arrangement used. In particular, the damage hen sliding a hemisphere on a flat plate is greater han when sliding two crossed cylinders inclined at a nall angle to each other. These differences in protection are attributed to the way in which the geometrical arrangement impedes or facilitates the growth of the initially small intermetallic junctions which form during sliding. The variation of the coefficient of friction with load has been studied, and for some metals deviations from Amontons's first law have been found. In such cases there exists a breakdown load above which both friction and surface damage markedly increase, and, for a given metal, the magnitude of this load depends on the method of formation of the surface oxide film. Film thickness is of relatively minor importance; the rate of formation of the oxide is of more significance, the greatest protection being found with films formed slowly at room temperature. Similar deviations from Amontons's law were also found under conditions of boundary lubrication, and the magnitude of the breakdown load is shown to depend on the combined properties of the boundary lubricant film and of the underlying oxide. The differences in protection given by differing oxide films on the same metal were often more noticeable in the presence of a lubricant, and an oxide film with poor protective properties can completely inhibit the potential protective action of the lubricant. Finally, it is shown that under lubricated conditions the work-hardened layer on an abraded metal may also act in conjunction with the oxide film and the lubricant in reducing the surface damage and friction during sliding. A.

539.622

6951. The rolling resistance of a wheel with a solid rubber tyre. I. Evans. *Brit. J. appl. Phys.*, **5**, 187–8 (*May*, 1954).

The rolling resistance of a wheel with a solid rubber tyre, running on a rigid plane surface, is calculated on the assumption that it is due to hysteresis losses in cyclic deformation of the rubber. The results and certain other deductions from the theory are in reasonably good agreement with experimental observations. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.2

6952. Influence of molecular structure of organic ompounds on their distribution between two liquid hases. L. Alders. *Appl. sci. Res.*, *A*, **4**, *No.* 3, 71–9 (1954).

Experiments are described from which it could be erived that for each series of homologous straight-hain organic compounds investigated the logarithm f the coefficient of distribution between a given olvent pair at infinite dilution is a linear function of he number of C atoms present in the alkyl group. Consequently this relation can be represented by the ormula $\log K_0 = A - Bn$, where A and B are onstants, and n equals the number of C atoms in the lkyl group. Moreover, for a given solvent pair, the ame value of B has been found for each homologous eries. Therefore, B may be taken as a measure of the light-heavy selectivity of the solvent pair concerned. A.

541.124

6953. Modes of decomposition of *n*-pentane. I. Pressure changes and mass spectrometric analysis. C. J. Danby, B. C. Spall, F. J. Stubbs and C. Hinshelwood. *Proc. Roy. Soc. A*, **223**, 421–9 (*May* 20, 1954).

Analyses by mass-spectrometry of the products formed in the nitric-oxide-inhibited decomposition of *n*-pentane have been made for a wide variety of temperatures, pressures and reaction percentages. The amounts of methane, propylene and ethylene formed are linear functions of the pressure change observed in the reaction. The same is true, though the random errors are greater for arithmetical reasons, for the amounts of pentane decomposed. An examination of the results shows that the kinetic peculiarities of the reaction cannot be explained

away by a failure of the pressure records by which the change is normally followed to indicate the true rate of reaction. A.

541.124

6954. Modes of decomposition of *n*-pentane. II. Kinetic considerations. B. C. SPALL, F. J. STUBBS AND C. HINSHELWOOD. *Proc. Roy. Soc. A*, **223**, 429–37 (*May* 20, 1954).

New or reworked, and in some cases corrected, experimental data confirm that in the decomposition of *n*-pentane there appear to be, in addition to the radical chain process, two modes of unimolecular reaction. One conforms approximately to the requirements of the classical theory with localization of activation energy in a critical bond (tentatively assumed to be a C–C bond), the non-exponential factor being the same order as a molecular vibration frequency. The other seems to involve a whole series of alternative transition states corresponding to different distributions of a given total energy among degrees of freedom thought to be probably movements of hydrogen atoms. Various possible implications about the gain, loss and redistribution of energy in the molecule are briefly considered. A.

541.124 : 536.7

6955. Addition to my paper: "The theory of irreversible processes. II." H. G. REIK. *Ann. Phys.* [*Leipzig*] **14**, *No.* 3–5, 174–6 (1954) *In German.*

See Abstr. 5150 (1953). Proof is given that the Pelzer–Wigner factor *L* [*Z. phys. Chem. B*, **15**, 445 (1932)] in the reaction velocity expression is unity for chemical reactions. C. TURNER

541.124 : 537.583

6956. Reduction of SrO by methane. G. E. MOORE, H. W. ALLISON AND K. B. WOLFSTIRN. *J. chem. Phys.*, **22**, 726–32 (*April*, 1954).

The reduction of SrO supported on purified platinum or nickel filaments was investigated over the range 1050 to 1700°K. Reduction is rapid, and at least part occurs in two major steps: (1) the methane dissociates, depositing carbon in the oxide, which (2) then reacts with SrO to give Sr and CO. When SrO is supported on platinum filaments a major part of the Sr enters the platinum. This is far less pronounced in nickel supports. Possible significance for the oxide cathode is discussed. Calculations indicate that SrC_2 may also be formed. A.

541.127

6957. An oscillographic method for determining velocities of detonation in explosives. F. C. GIBSON. *Rev. sci. Instrum.*, **25**, 226–31 (*March*, 1954).

The method and apparatus are described for determining velocities of detonation over one to five adjacent segments of an explosive charge. Time intervals are determined to the nearest 0·1 μsec, which permits an accuracy of the order of 1% where distances of 10 cm are employed in 7000 m/sec explosives. Representative data are included to show the accuracy of the method as well as application techniques. A.

541.127

6958. The rate constant of the reaction between hydrogen peroxide and ferrous ions. T. RIGG, W. TAYLOR AND JOS. WEISS. *J. chem. Phys.*, **22**, 575– (*April*, 1954).

The rate constant of the reaction between hydroge peroxide and ferrous ions has been measured i sulphuric acid solutions, by direct spectrophotometri observations of the ferric salt produced at $\lambda = 304$ mμ It has been confirmed that the rate is independent o acidity (measurements were carried out from 0·05 to 0·8 N H_2SO_4) and that the reaction is bimolecula within a wide range of the concentrations of th reactants; the hydrogen peroxide concentration wa varied in the ratio 1 : 25 and the ferrous sulphate i the ratio 1 : 20. The rate constant, which has bee measured within the temperature range of 15° t 40°C, can be represented by the equation $k_1 =$ $1{\cdot}05 \times 10^8 \times \exp(-8460/RT)$ l. mole^{-1} sec^{-1}. A

541.12

6959. Catalysis on evaporated metal films. II The efficiency of different metals for the reactio between ethane and deuterium. J. R. ANDERSON AN C. KEMBALL. *Proc. Roy. Soc. A*, **223**, 361–77 (*May* 1954).

For Pt II, see Abstr. 5159 (1953). The catalyze exchange reaction between ethane and deuterium ha been studied over evaporated films of W, Mo, T Zr, Cr, V, Ni, Pt, Pd, Rh and Ru. Manganese, silv and iron films were inactive up to 370°C, but the latt produced some highly deuterated methane. Coba showed simultaneous cracking and exchange at 300 and cracking was observed on nickel above 160° The initial distribution of the deutero-ethanes fe into three classes which are exemplified by moly denum, palladium and chromium. With molybdenu the main product was C_2H_5D, with palladium C_2D and both were major products with chromium. theory is developed which accounts for the observe distributions in terms of the relative probability of a adsorbed ethyl radical either desorbing as ethane adsorbing further to ethylene—the highly deuterate products being formed by repeated transitions betwe ethyl radical and ethylene residue. The energies activation ranged from 7 kcal/mole for molybdenu to 21 kcal/mole for palladium, and high-frequen factors were associated with high energies of activ tion. The orders of reaction with respect to bo gases were determined on tungsten, palladium a rhodium, and possible mechanisms are formulate Some evidence that different crystal faces had differe catalytic activities was obtained by comparing t distribution of products formed on oriented a unoriented nickel films. Nickel films showed falling energy of activation in the temperature ran 0 to 75°C and evidence was obtained that this was d to a reversible shift in the equilibrium amounts different adsorbed species.

541.1

6960. Catalysis on evaporated metal films. I Exchange between propane and deuterium and *is* butane and deuterium. C. KEMBALL. *Proc. Ro Soc. A*, **223**, 377–92 (*May* 6, 1954).

The exchange reactions of propane and *iso*buta have been followed on evaporated films of tungst rhodium and nickel by means of a mass-spectromet The energies of activation and frequency factors we

proximately the same as those for the exchange action of ethane on tungsten and rhodium. Nickel was were effective at a slightly lower temperature the exchange of propane and *iso*butane than for ane but showed the same phenomenon of decreas- energy of activation above 0°C as had been served for the reaction of ethane. The orders of action with respect to gas pressures were deter- ined for the exchange of propane on all three alysts. It appeared from the study of the initial oducts that the ability of rhodium to bring about ultiple exchange is a characteristic property of that tal for hydrocarbon exchange reactions, in contrast tungsten where the exchange is mainly brought out by successive replacement of the hydrogen oms. Nickel showed appreciable differences in the e of exchange of primary, secondary and tertiary drogen atoms. The rates of exchange of the condary hydrogens in propane and the tertiary drogen in *iso*butane were ten times faster than the tes for the primary hydrogens in the respective mpounds. A.

ELECTROCHEMISTRY 541.13

541.131

961. Residual currents. E. NEWBERY. *Trans oy. Soc. S. Africa*, **34**, *Pt* 1, 25–41 (1954).

The current flowing between two unattackable ectrodes under the influence of a potential difference ss than the decomposition voltage of the electrolyte as been investigated and found to be extremely mplex. Curves have been constructed showing the riation of current with time, when the applied m.f. is changed by steps of $\pm 0{\cdot}1$ V. These curves e not appreciably affected by change of shape of ectrolysis vessel or distance between the electrodes, by change of electrode from smooth Pt to smooth u, but they are greatly altered (*a*) by change of echanical condition of the electrode surface, (*b*) by eing the electrodes by using them in these experi- ents for long periods, and (*c*) by using an electrolyte om which a metal instead of a gas tends to deposit n one electrode. Shaking an electrode or stirring e surrounding electrolyte during the application of n e.m.f. increases the current flowing if a gas tends deposit on that electrode, but not if a metal tends deposit. Increases up to 800% have been observed ith freshly platinized electrodes and less than 20% ith aged smooth electrodes. The current passed is ecoverable when used (*a*) in generating gas at one or oth electrodes at low pressures, thus forming high- apacity condensers, (*b*) in charging these condensers, nd (*c*) in generating more gas to replace that lost by iffusion into the electrolyte in the molecular state, nd into the electrodes in the atomic state. A con- iderable proportion of the total residual current, sually over 80%, is irrecoverable, and only a very mall fraction of the irrecoverable part can reasonably e accounted for by the normal processes of diffusion, tc. It follows therefore that at least 75% of the bserved residual current is carried by some process hich does not conform with Faraday's laws. It is uggested that under the influence of a very high potential gradient across an attenuated gas-film covering the electrodes, electrons may be extracted or deposited with production of current not associated with the transport of ions through the electrolyte. A.

541.133

6962. On the molecular conductivity of dyestuffs in solution. I. K. CHAUDHARY. *Pakistan J. sci. Res.*, **4**, 114–17 (*Oct.*, 1952).

The molecular conductivities of certain dyestuffs have been determined by a method which is described. It was found that in most of the cases the molecular conductivities of dyestuffs in solution did not have linear relations with the square root of concentration. The departure of the conductivity curve from the perfect straight line has been explained as being due to the formation of ionic micelles with increase in concentrations [see also Abstr. 2783 (1953)]. A.

541.135 : 530.162

6963. A theory of strong electrolytes in solution based on a new statistics. Equilibrium phenomena: activity coefficients. M. DUTTA AND M. SENGUPTA. *Proc. Nat. Inst. Sci. India*, **20**, 1–11 (*Jan.–Feb.*, 1954).

In this paper, a complete scheme of calculation of activity coefficients has been sketched based on the new statistics proposed by Dutta [Abstr. 4181 (1952)] and by Dutta and Bagchi [Abstr. 7559 (1950)]. The agreement of the observed and the calculated values of activity coefficients is found to be good. The values of the activity coefficients for different concentrations and for different temperatures have been calculated and have been given in two tables. Some inconsistencies of the other existing theories, mainly of the theory of Debye and Hückel, are pointed out and how these can be avoided easily in the present development is clearly shown. A.

541.135.5

6964. Study of the voltage-current curves of the thallium ion obtained with a renewed mercury cathode of constant surface. M.-P. SIMONNIN AND M. QUINTIN. *C.R. Acad. Sci.* [*Paris*] **238**, 892–4 (*Feb.* 22, 1954) *In French.*

The renewed mercury cathode previously described [Abstr. 3971 (1954)] is used with the reference electrode Ag/AgCl for obtaining the voltage-current curves of the Tl^+ ion during the electrolysis of thallium nitrate. The curves are compared with the classical polarographic curves. The height of the step is proportional to the concentration of the electro-reducible ion, and the initial wave potential independent of it, on analogy with the polarographic data. The slope and potentials of the half-step and of the termination of the wave, on the other hand, are linear functions of the square root of the concentration of the electro-reducible ion. Four curves. H. H. HODGSON

541.135.5

6965. Study of the voltage-current curves for some divalent ions obtained with a renewed mercury cathode of constant surface. M.-P. SIMONNIN. *C.R. Acad. Sci.* [*Paris*] **238**, 1031–3 (*March* 1, 1954) *In French.*

The renewed mercury cathode (preceding abstract) is used to examine the behaviour of the divalent ions Cd^{++}, Ni^{++} and Zn^{++} in $0{\cdot}1$ N KCl medium for concentrations between 10^{-4} and $3{\cdot}2\times10^{-3}$ N. Four voltage-current curves are obtained which are very

similar to those for the Tl^+ ion, and the conclusions drawn from them are the same except that the constant connecting the variation of the slope with the square root of the concentration is different for each of the divalent ions. The variation of the height h of the step with the concentration c affords a constant K ($h = Kc$) which is numerically identical with that for Tl^+, and indicates that h is independent of the diffusion coefficient of the electro-reducible ion and dependent only on c and the geometrical characteristics of the cell employed. H. H. HODGSON

541.136 : 536.7

6966. The Onsager thermodynamics of galvanic cells with liquid-liquid junctions. R. J. BEARMAN. *J. chem. Phys.*, **22**, 585–7 (*April*, 1954).

The general theory of galvanic cells with liquid-liquid junctions, including gravitational effects, is discussed by means of the Onsager thermodynamics of irreversible processes. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY
541.14/.15

541.144

6967. The combination of methyl radicals: photolysis of acetone at low pressures. R. E. DODD AND E. W. R. STEACIE. *Proc. Roy. Soc. A*, **223**, 283–95 (*May* 6, 1954).

The kinetics of the photodecomposition of acetone at low pressures (20 to 0·2 mm) are consistent with the participation of a third body in the recombination of methyl radicals. Various added gases increase the relative rate of formation of ethane; approximate values, relative to acetone, are given for their efficiencies in deactivating excited ethane molecules by collision. The rate of spontaneous redissociation of the activated complex is less than 6×10^7 sec^{-1} at 520°K, and increases with temperature. A.

541.15

6968. Energy transfer in macromolecules exposed to ionising radiations. P. ALEXANDER AND A. CHARLESBY. *Nature* [*London*] **173**, 578–9 (*March* 27, 1954).

Results of "protection" experiments on the degradation of polymethylmethacrylate and of poly*iso*butylene by γ- and pile-radiations, and on the radiation dose required to render a straight-chain hydrocarbon infusible, lead to the conclusion that energy transfer can occur within saturated macromolecules.

C. B. ALLSOPP

541.15

6969. The radical pair yield of ionizing radiation in sulphuric acid solution. E. R. JOHNSON AND JER. WEISS. Letter in *J. chem. Phys.*, **22**, 752–3 (*April*, 1954).

Ceric sulphate solutions (10^{-1} to 10^{-3} M in 0·8 N H_2SO_4) were irradiated from a Co^{60} source while N_2, He, H_2, air and CO respectively were bubbled through at 300 cm^3/min. In the presence of CO or H_2 the rate of reduction of ceric ion was about twice as great as in the presence of air, N_2 or He. In other experiments the solutions were first saturated with CO and then irradiated with X-rays. The rate of CO_2 formation in ceric solutions was the same as with H_2SO_4 alone. The rate of ceric ion reduction in t presence of CO is about twice that of the norm reduction in sulphuric acid. It is suggested that H_2 produced in the reaction $2H_2O \rightarrow H_2 + H_2O_2$ either destroyed or does not exist as such, and mechanism for ceric ion reduction is proposed. gives 2·54 per 100 eV as the radical pair yield for sulphuric acid solution. C. B. ALLSO

541

6970. Effect of molecular weight on the cross-link of siloxanes by high-energy radiation. A. CHARLES Letter in *Nature* [*London*] **173**, 679–80 (*April* 10, 195

Polydimethylsiloxanes of various viscosities w subjected to BEPO pile or Co^{60} radiation and minimum radiation dose needed to prevent melting temperatures up to 200°C was recorded. Over molecular weight range 2000 to 115 000 the prod of radiation dose × molecular weight is constant, that the dose required to produce an average of cross-link per weight average molecule is inver proportional to the number of units in the molec and the dose required to cross-link a given proport of the monomer units is independent of molecu length. For the higher polymers, unit pile radiat results in 2·3 cross-links per 100 monomer un independent of the molecular weight. C. B. ALLS

541

6971. Some effects of irradiation on Nylon polyethylene terephthalate. K. LITTLE. Letter *Nature* [*London*] **173**, 680 (*April* 10, 1954).

Some physical and chemical results of irradiati of 66-Nylon and of Terylene in the BEPO pile investigated and shown to be quite different for two polymers. A tendency in the literature to descr any effect in which low doses of radiation ca changed solubilities, increased melting points and gross chemical breakdown as cross-linking is e neous. In the case of the experiments on Teryle extensive bridge formation could not have occur C. B. ALLS

541

6972. The degradation of solid polymethylmet crylate by ionizing radiation. P. ALEXANDER, CHARLESBY AND M. ROSS. *Proc. Roy. Soc. A*, 2 392–404 (*May* 6, 1954).

When polymethylmethacrylate in the solid form irradiated in the atomic pile, or with γ-radiation, t reactions predominate: breakdown of the main cha and decomposition of the side chain with evolut of gases. The former was followed by changes viscosity, the molecular weight of the irradia polymer being inversely proportional to the radiat dose (plus a small quantity of R_0 which depends the initial molecular weight). The degradation thought to proceed by random rupture of main-ch C–C bonds by rearrangement of the excited polym and 61 eV are absorbed per fractured bond. For e main-chain rupture approximately one ester s chain is also decomposed. The cage effect is thou to prevent direct dissociation, and reaction occurs rearrangement of the molecule to give relatively sta entities. Added substances reduce the amount degradation, possibly by transfer of energy from excited polymer molecule. This is only possible if excited molecules have an appreciable life bef

...mposition. Viscosity measurements on irradiated ... methylmethacrylate in the solid form offer a ...ible means of measuring high-energy radiation ...s in the range of about 1 million röntgens and ...ards. A.

541.15

...3. Molecular-weight changes in the degradation ...ong-chain polymers. A. CHARLESBY. *Proc. Roy. ... A*, **224**, 120–8 (*June* 9, 1954).

...he changes in molecular weight of a long-chain ...mer (initially of arbitrary molecular-weight ...ribution) are studied when the main chain is ...ected to random fracture, such as occurs when ...ain polymers are exposed to high-energy radiation. ... several distributions studied, all trace of the ...ial distribution curve is lost after an average of ...e 3 to 8 main-chain fractures per molecule. For ...er degrees of degradation the shape of the curve ...weight average against degradation can provide ...rmation as to the initial weight average, *z* average, ...- 1 average molecular weights. The initial number-...rage can be obtained by a method of extrapolation. A.

...SPERSIONS . COLLOIDS . ADSORPTION

541.18

541.18.04

...4. Coagulation of colloid particles. M. TSUJI. ...*m. Fac. Sci. Kyusyu Univ. B*, **1**, 74–9 (*March*, ...53).

...t is shown that the general solutions of the ...oluchowski equation for the coagulation of colloid ...rticles are obtained by the method of Laplace ...nsform. As an example, some special solutions ... presented. Finally it is shown that all the size ...tributions become, after sufficient time, nearly ...ponential in form. A.

541.18.043

...5. On the characteristics of the disc-type centri...ge. Y. OYAMA AND I. INOUE. *J. Sci. Res. Inst. ...okyo*] **47**, 205–15 (*Dec.*, 1953).

The characteristics of the disk-type centrifuge as a ...uid-liquid separator were studied experimentally. ... it was found that the usual formula for the position ... so-called neutral zone did not apply rigorously in ...tual operations, a mathematical relationship ...tween the position of the newly-defined neutral ...ne and the feed rate, available for many cases, was ...roduced. A.

541.18.05

...6. Conditions of the spontaneous disintegration of ...ops during emulsification. L. YA. KREMNEV AND ... A. RAVDEL'. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 3, ...5–7 (1953) *In Russian.*

According to Rebinder [*Kolloidnyi Zhurnal*, **8**, 157 (1946)], the dispersion of the disperse phase of an ...mulsion is effected by the spontaneous disintegration ... drops which are stretched beyond a certain critical ...tio $h/a = 2.\pi$, where h is the height and r the radius ... the base of the liquid cylinder. Mathematical ...alysis shows that, irrespective of the relative radii ... the two resultant drops, the least favourable ...nditions for disintegration are when the ratio $\Sigma S_d/S_c$ (the sum of surfaces of the resultant drops, divided by the surface of the cylinder) equals 2. Values below 2 favour the disintegration much more than those above 2. Hence the unstable condition of the cylindrical drop can be attained at small compression values. Finally, the disintegration occurs more readily for large values of the ratio $\Sigma S_d/S_c$ than for the smaller ones. F. LACHMAN

541.182.4 : 535.345

6977. Determination of interfacial area in unstable emulsions by light transmission. G. E. LANGLOIS, J. E. GULLBERG AND T. VERMEULEN. *Rev. sci. Instrum.*, **25**, 360–3 (*April*, 1954).

Total interfacial area can be determined in agitated mixtures of transparent immiscible liquids by calculation from photoelectric measurements of their light transmission relative to clear fluids, with a probe of new design which is inserted into the emulsion. The probe is compact and rugged, and can be assembled from a simply constructed housing together with commercially available parts. A calibration obtained by high-speed photography of the emulsions is presented. The drop diameters measured were in the range of 0·01 to 0·10 cm, and, in this range, the specific area is found to depend only upon the light transmission and the ratio of refractive indexes of the dispersed and continuous phases. A.

541.183

6978. Adsorption of a gas phase on a solid surface. R. SEIDL. *Czech. J. Phys.*, **3**, 258 (*Sept.*, 1953) *In German.*

From experiments on the condensation of vapours (especially cadmium, zinc and mercury) on cooled surfaces, it is concluded that (*a*) adsorption occurs only if the kinetic energy of the incident molecules is below a certain critical figure, characteristic of the binding energy between vapour and solid; (*b*) that the collisions of the molecules with the solid are not necessarily inelastic, and that there may be true reflection, especially with molecules of higher energy. Frenkel's theory [*Z. Phys.*, **26**, 117 (1924)] therefore represents an approximation, deviations from experiments becoming greater as temperature rises.

S. J. GREGG

541.183

6979. Random walk with semiadsorbing barrier. F. C. GOODRICH. *J. chem. Phys.*, **22**, 588–94 (*April*, 1954).

The problem of random walk in the presence of a semiadsorbing barrier is formulated and discussed. The results are applied to a study of the kinetics of adsorption in colloidal systems. A.

CHEMICAL STRUCTURE 541.2/.6

541.23

6980. Determination of atomic masses [weights] by the pykno–X-ray method. T. BATUECAS. *Nature* [*London*] **173**, 345–6 (*Feb.* 20, 1954).

See Abstr. 3336 (1950). The value $6{\cdot}0236 \pm 7 \times 10^{23}$ is adopted for Avogadro's number, based on X-ray and pyknometric data for diamond. Combining this with densities determined by Batuecas and his co-workers and lattice parameters from the literature for

NaCl, As_4O_6, SiO_2, Si and $CaCO_3$ gives the atomic weights Na = 22·996 ± 0·009, As = 74·905 ± 0·015, Si = 28·081 ± 0·007, Ca = 40·094 ± 0·017.

A. J. C. WILSON

541.24 : 541.64 : 535.371 : 535.343.32

Spectroscopic and fluorescence determination of the molecular weight of high chain-polymers. *See Abstr.* 6487

541.64

6981. Network theory of the gel point and the "incestuous" polymerization of diallyl phthalate. M. GORDON. *J. chem. Phys.*, **22**, 610–13 (*April*, 1954).

The status of the gel point equation, advanced by Flory, Stockmayer and Walling for polyfunctional reactions, is briefly discussed. Two complicating factors in the chain polymerization of divinyl compounds, to which this equation has been applied, are reviewed: the admixture of a monovinyl compound of comparable reactivity, and the "incestuous" tendency for the two double bonds in a divinyl compound to enter the same polymerization chain. Contrary to the treatment by Simpson and co-workers, these two factors are found to demand different theoretical approaches. The progress of polymerization enriches the monomer mixture in the monovinyl compound, while the incestuous tendency remains constant. Kinetic derivations are given for the gel point condition in both cases. The gel point in the "incestuous" polymerization of diallyl phthalate is calculated to lie at conversions 40% higher than estimated by Simpson and co-workers, and much better agreement is thus achieved with their experimental measurements. A simple network theory suffices to predict the gel point in two chain polymerization reactions. Substantial delays of the gel point, predicted by Walling's theory of diffusion control in such reactions, are not encountered. A.

541.65

6982. Infrared studies of solutions involving aromatics and halogens. W. HALLER, G. JURA AND G. C. PIMENTEL. *J. chem. Phys.*, **22**, 720–2 (*April*, 1954).

Infrared studies were made in the region 640–1400 cm^{-1} to investigate the effect of adding iodine to benzene, toluene, mesitylene, hexamethylbenzene, naphthalene, cyclohexane and methylcyclohexane. Spectral changes were observed for each of the aromatics except for naphthalene. The enhancement of the mesitylene band at 1300 cm^{-1} was observed for mesitylene purified in five distinct ways. The enhancement of the hexamethylbenzene band at 1298 cm^{-1} was studied as a function of the concentrations in carbon disulphide solutions and correlates with the product of hexamethylbenzene and iodine concentrations. The effect of bromine on the spectrum of benzene was noted also. The results can be discussed in terms of weak complex formation or strong solvent perturbations. A.

LABORATORY APPARATUS 542.1/.7

542.41 : 621.365.4

6983. High-temperature pressure furnace. G. BUSCH, F. HULLIGER AND U. WINKLER. *Helv. phys. A* **27**, *No.* 1, 74–80 (1954) *In German.*

A detailed description of the furnace is giv The maximum temperature reached was 2800°C v a maximum loading of 30 kW under vacuum; it also be used at pressures up to 10 atm. The heating time is short and the temperature can be maintai for long periods to within about 25°C. Temperatu up to 1500°C are measured with a Pt–PtRh ther couple and above this with a radiation pyrom sighted through a Plexiglass window. E. H. D

542.47 : 53

6984. Theory of thermogradient drying of fi B. V. DERYAGIN, N. N. GOUFMAN, A. G. AMI AND S. M. LEVI. *Dokl. Akad. Nauk SSSR*, **92**, *No* 759–62 (1953) *In Russian.* English translation, *National Sci. Found. NSF-tr*-213.

The drying of a thin layer deposited on a flex base is discussed. The layer surface SS is kept a maximum temperature t_1 by means of a para heating surface KK at distance M from the and a parallel condenser surface UU, cooled to t_2 means of a freezing mixture, at distance H from The mechanism and rate of moisture removal f SS is examined. The rate of drying W_k ($g.cm^{-2}$ se is expressed as $0{\cdot}89Dv^{-\frac{1}{2}}(d_1 - d_2)[(\rho_1 - \rho^2)/\rho_{av}$ where d_1, d_2 are the moisture contents ($g.cm^{-3}$ SS and UU respectively, D the diffusion coeff water vapour in air, ν the kinematic viscosity, ρ_1 the densities of the moist air at SS and respectively and ρ_{av} the average density. Value W_k for various temperature intervals and for H to 10 cm are tabulated. The advantages of the dry method, particularly the elimination of dust parti falling on the sample, are emphasized. The correc necessary for the assumption of vapour condensa occurring only on UU and the allowance requ in W_k for the effect of fog are discussed. The res of an experimental check show that the experime W_k is about twice the theoretical. S. WEINTR

CHEMICAL PROCESSES 542.9

542.9

6985. Studies in polymerization. VII. The p merization of *n*-carboxy-α-amino acid anhydri D. G. H. BALLARD AND C. H. BAMFORD. *Proc. R Soc. A*, **223**, 495–520 (*May* 20, 1954).

For Pt VI, see Abstr. 4457 (1953).

CHEMICAL ANALYSIS 543/545

545.

6986. Redistribution of the intensities of spectral li of elements in a discharge in argon. K. N. MOCHA AND E. L. RAFF. *Dokl. Akad. Nauk SSSR*, **91**, *No* 1067–70 (1953) *In Russian.* English translation, *National Sci. Found. NSF-tr*-174.

Spectral analysis of alloys by arc discharge in is complicated by the occurrence of intense chem reactions. The line intensities are poorly reproduci Spectra have now been taken in argon and compa

those in air under similar electrical conditions, duration of exposure being different. In the Fe rum, the short-wave lines became stronger in n, the long-wave weaker. New lines appeared h were absent in air, whilst some weakened and disappeared. The lines of Fe ions became nger, those of atoms weaker. These effects were d for some 20 metals; they persisted even for metals present only as traces in alloys. Some weak lines, however, do not exhibit this behaviour. The results were also found for the anode metal of a d.c. arc. They are probably caused by the higher ionization potential of argon, 15·7 V compared with 12 V for air. In the spectra of W, Mo, V, Al, the use of argon eliminates the interfering background which hinders measurements. A. J. TAYLOR

CRYSTALLOGRAPHY 548

548.1 : 515

7. A practical method for transforming crystal eograms into gnomonic projection. R. L. PARKER. *angew. Math. Phys.*, **4**, *No.* 6, 497–9 (1953) *In man.*

he method is based on the fact that both projecns have a small circle in common. The construction also be used for the direct construction of gnonograms if the positional angles of the faces are wn. Combined gnomonostereograms connected the common small circle may also be drawn. A.

548.5

8. Fibrous ice [Kammeis], an anomalous growthm of ice crystals. S. STEINEMANN. *Z. angew. ath. Phys.*, **4**, *No.* 6, 500–6 (1953) *In German.*

Fibrous ice is a form of frost in soils. The fibres w in the underlying melt and are pushed upward. e habit is sometimes described as hexagonal sms. This could in general not be verified, and an alysis with the universal stage showed that the tical axis of the crystallites lie preferentially perndicular to the direction of growth and so to the mperature gradient. This is an anomaly in the owth of crystals from a melt. A.

548.5

89. A method for growing barium titanate single ystals. J. P. REMEIKA. Note in *J. Amer. Chem. Soc.*, , 940–1 (*Feb.*, 1954).

Clear single crystal plates of $BaTiO_3$ have been epared from a fused mixture of 30% $BaTiO_3$, 2% Fe_2O_3 and 69·8% KF. The crystals have ctangular hysteresis loop characteristics. Addition Fe_2O_3 converts the titanate from an *n*-type to a type semiconductor and also lowers the Curie mperature. J. FRANKS

548.5

90. Morphology of ZnO crystals formed on the rface of brass or zinc at high temperatures. . TAKAGI. *J. Phys. Soc. Japan*, **9**, 162–8 (*March–pril*, 1954).

It was electron-microscopically observed that thin eedles project from the surface of brass or zinc eated in air. Electron diffraction diagrams proved at they are needle-shaped crystals of hexagonal nO with axes parallel to the [110] direction; this resents an interesting contrast to the ZnO smoke eedles having axes parallel to [001]. For brass, eedle-shaped crystals begin to form at about 300°c nd the largest crystals grow at 550–650°c. At temeratures higher than 700°c the growth of the needles is suppressed and no oxide is found at all near the melting point. In the case of zinc, the largest crystals are obtained at 450–550°c (melting point 419°c), where dendritic crystals having 60° branching are observed together with flat sword-like crystals. When the substrate brass or zinc is heavily distorted, plate-shaped ZnO crystals showing rotational slips are obtained. A.

548.5

6991. The production of single crystals of metals and alloys with any desired orientation by solidification at high temperature. H. TAKAKI, S. NAKAMURA, Y. NAKAMURA, J. HAYASHI, K. FURUKAWA AND M. ASO. *J. Phys. Soc. Japan*, **9**, 204–8 (*March–April*, 1954).

In order to grow single crystals of metals and alloys with fairly high melting point in large rods with any desired orientation, a method is developed from the Bridgman method, using a vacuum Tammann furnace and porcelain crucibles with no bottom, sometimes with a perforated sectorial plate, and inserting a seed into the lowest part of the crucible. Single crystals of 3·2% and 4·0% silicon steel, and pure nickel, 3 mm dia. and 25 cm long were obtained. The rod axes can be fixed in any desired direction. It is noted that the maximum velocity of lowering the crucible and its contents, below which a large crystal can grow at each orientation, shows very large anisotropy. A.

548.5

6992. Regrowth of silicon through a low melting zone of silicon-gold eutectic. J. N. CARMAN, P. E. STELLO AND C. A. BITTMANN. Letter in *J. appl. Phys.*, **25**, 543 (*April*, 1954).

W. G. Pfann's zone melting technique [*Transactions of the American Institute of Mining and Metallurgical Engineers*, **194**, 747 (1952)] was used. The specimen consisted of a Si seed, a zone of Si–Au eutectic (eutectic point 370°c and composition 6% Si, 94% Au) and a source of silicon. *p*-Type crystals, free from occluded Au, up to $\frac{3}{4}$ in. in length and of 4 ohm.cm resistivity were obtained, with best results for heater rate-of-movement of 10^{-3} in./hr. S. WEINTROUB

548.5

6993. Mixed crystal formation in the system TiO–TiN. O. SCHMITZ-DUMONT AND K. STEINBERG. Note in *Naturwissenschaften*, **41**, 117 (*March*, 1954) *In German.*

TiO and TiN both crystallize in the rock salt lattice, with lattice constants only 2% different. The lattice constant and the density of mixed crystals are

quite different functions of composition. The difference is accounted for by changes in the number of lattice vacancies, 16% for TiO and 2% for TiN.

W. M. LOMER

548.5 : 537.583

6994. Thermionic and surface properties of tungsten crystals. G. F. SMITH. *Phys. Rev.*, **94**, 295–308 (*April* 15, 1954).

A plateau-like surface structure was found on single crystals grown in tungsten wire. Plateaux were observed on the surface normal to the (110), (112) and (001) directions. A "shingle" structure was observed superimposed upon the plateaux. A wire subjected to only mild heat treatment showed both types of structure, indicating that evaporation cannot be the only mechanism involved. All wires were heated by a.c. exclusively to avoid the "d.c. etch." New values of the thermionic constants for different crystal directions were measured on a crystal having a minimum of shingling. Measurements were made in the tube previously used by Nichols, modified to eliminate an anomalous effect. The modification did not appreciably alter the emission constants for the (111), (112), (116) and (001) directions, which constants are in reasonable agreement with Nichols' values. A second anomalous effect contributed to currents measured in the low emission (110) direction, rendering normally obtained (110) values erroneous (including those of Nichols). Although the true (110) constants could not be obtained, an upper limit for the emission is characterized by $\phi^{**} = 4{\cdot}72$, $A^{**} = 9{\cdot}7$ and two estimates of about 5·3 V are deduced for ϕ^{**}. There was no evidence in general for patchiness of the single crystal surfaces investigated; however, the usual tests cannot conclusively deny the existence of patchiness.

A.

548.5 : 537.583

6995. Growth and surface properties of tantalum crystals. M. H. NICHOLS. *Phys. Rev.*, **94**, 309–13 (*April* 15, 1954).

A method consisting of a moving temperature gradient for producing centimetre-long crystals in commercial tantalum wire is described. Based on one run, the method was less successful on commercial molybdenum wire. Thermionic projection tube patterns from the resulting crystals were qualitatively the same as that from tungsten. Plateau-like structure similar to that of tungsten was observed on both the tantalum and molybdenum crystals.

A.

548.535

6996. Floating zone recrystallization of silicon. P. H. KECK, W. VAN HORN, J. SOLED AND M. MACDONALD. *Rev. sci. Instrum.*, **25**, 331–4 (*April*, 1954).

Equipment to carry out recrystallization and zone melting of silicon from a floating liquid zone is described. In the first design, silicon was melted by a tungsten ring. In an improved apparatus, no heater element inside the melting chamber is necessary, since the silicon is melted by induction heating. The system is capable of producing crystals of extreme purity. Silicon single crystals of resistivities up to several hundred ohm.cm have been grown with the described equipment.

A.

548

6997. The dimensions of ideal crystal lattices. A. SMEKAL. *S.B. Österr. Akad. Wiss. IIa*, **162**, *No.* 147–56 (1953) *In German.*

A survey of recent papers on the factors t determine the size of single crystals. Materials w high symmetries and strong bonds have ideal ar of microscopic dimensions, while metals and s have submicroscopic ideal areas. The size is a slightly dependent on thermal movements and v much on impurities present in solid solution.

C. TURI

548.

6998. Etch trigons on diamonds. J. F. H. CUST AND H. R. SIMPSON. Letter in *Nature* [*London*] 738 (*April* 17, 1954).

Trigons were formed on the slightly polished (l cleavage face of diamond by etching with air 1400°c for 2 min. Details of the trigons obser are given and illustrated by photomicrogra Many trigons show cross-bridges and some, especi the well-developed ones without bridges, appea be arranged along spirals. Large negative trig were also observed.

S. WEINTR

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

54

6999. On the electronic polaron state. TOYOZAWA. Letter in *Progr. theor. Phys.*, **9**, 67 (*June*, 1953).

The electronic polarization in an insulator due the passage of a conduction electron is treated the band picture in the same way as the interact of a conduction electron with the lattice, the polar corresponding to phonons. The effect of impuri is also discussed. The main conclusions are a retar tion of the electronic polarization and a modi high-frequency dielectric constant.

F. ANSBAC

54

7000. Spatial correlation of electrons in sq tetragonally distorted A1 structures. K. SCHUBE Note in *Z. Naturforsch.*, **9a**, 261–2 (*March*, 1954) *German.*

Preliminary discussion of types of binding in wh correlations involving *d*-electrons play a part.

E. H. SONDHEI

54

7001. Polaron self-energy and Bloch–Nordsi method. K. S. SINGWI AND B. M. UDGAONK *Phys. Rev.*, **94**, 38–42 (*April* 1, 1954).

By using the Bloch–Nordsieck method the s energy of a polaron has been investigated in t limiting cases: (i) when the polaron velocity is l i.e. $mv^2 < \hbar\omega$, and (ii) when the velocity is high, $mv^2 > \hbar\omega$. In case (i), this method gives res which are no better than those obtained by the of the customary second-order perturbation the when the coupling constant is large. The contribut of the phonons of large momenta, if not more, is

st as much as that of the phonons of low momenta. wever, in case (ii), the authors hope that their ults are more satisfactory in view of the fact that assumptions of the B — N method are better tified. In this case the self-energy is found to y inversely as the velocity. A.

548.7

02. The effective mass of electrons in crystals. Kittel. *Amer. J. Phys.*, **22**, 250–2 (*May*, 1954).

The transfer of momentum between a conduction ctron and a crystal lattice is examined in detail. ysical considerations lead to the expression $\left(\frac{m}{m^*}\right)_{ij} = \delta_{ij} + \sum_{\mathbf{G}} G_i \frac{\partial}{\partial k_j} |a_{\mathbf{G}}(\mathbf{k})|^2$ for the reciprocal ective mass tensor, where **G** is 2π times a reciprocal tice vector and $a_{\mathbf{G}}(\mathbf{k})$ is a coefficient in the omentum representation of the Bloch eigenfunction: $= \sum_{\mathbf{G}} a_{\mathbf{G}}(\mathbf{k}) \exp[i(\mathbf{G} + \mathbf{k}\cdot\mathbf{r}]$. This expression for e effective mass tensor is shown to be completely uivalent to the usual definition. A.

548.7 : 539.11

Exchange energy of electrons in metals and ionic ystals. *See Abstr.* 6767

548.7

003. On the possible development of the theory of slocations. V. I. Arkharov, G. N. Kolesnikov nd A. N. Orlov. *Dokl. Akad. Nauk SSSR*, **92**, o. 4, 751–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-212.

The authors try to explain the origin of dislocations crystals by a generalization of Seitz's vacancy ondensation mechanism. Two pairs of edge dislocations of finite length and lying in parallel planes ith their ends connected by eight [*sic*] screw dislocations form a "bounded" dislocation. In the limit hen the slip planes are one atomic spacing apart, nd the edge dislocations one atom long, the bounded islocation becomes a single interstitial atom and a ingle vacancy. It is suggested that single defects are ormed thermally, and continually condense and lisperse. Under stress, the dislocations associated ith large groups may move as such, but at high emp. vacancies will diffuse away from groups too mall to move as dislocations under the applied stress, hus explaining the change-over to diffusion creep.

W. M. LOMER

548.7

7004. Frenkel type defects and the melting of silver halide crystals. Z. Matyáš. *Czech. J. Phys.*, **4**, 14–25 (*Feb.*, 1954).

The author assumes that the melting of the crystals is connected with the passage of ions into interstitial positions. He introduces the assumption about the dependence of the energy of the crystal on the degree of order and from the above, by the method of statistical thermodynamics, he calculates the free energy of the crystal as a function of the temperature and a parameter characterizing the degree of order. By a discussion of the isotherms of the free energy he then obtains the melting temperature at which the degree of order changes suddenly. From this discontinuity the latent heat and the entropy can be determined. The calculated values are in good agreement with experiment. A.

548.7

7005. Jogs in dislocation lines. A. Seeger and H. Blank. Note in *Z. Naturforsch.*, **9a**, 262–3 (*March*, 1954) *In German.*

Discusses the dependence of the character of the jog upon the form of the crystal lattice and upon the nature of the dislocation lines. E. H. SONDHEIMER

548.7

7006. On a method of formulating the statistics of dislocations. H. Donth. Note in *Z. Naturforsch.*, **9a**, 264 (*March*, 1954) *In German.*

Outline of a theory in which the motion in phase space of a dislocation element is described as a double Markoff process. E. H. SONDHEIMER

548.7

7007. Diffraction effects of crystals with deformation faults. R. Hosemann and S. N. Bagchi. *Phys. Rev.*, **94**, 71–4 (*April* 1, 1954).

The theory of ideal paracrystals is applied to the problem of the diffraction effects of face-centred cubic crystals with deformation faults (as distinct from growth faults) in the plane (111). It is shown that the formulae given by Paterson are more easily deduced with the help of this theory and the problem of Paterson is only a special case (e.g. the case of infinitely large crystals and of co-ordination statistics given by peak functions) of the general deformation effects postulated in this theory. A.

548.7 : 539.11 : 535.343.2–14/15

Study of crystal defects in solids with the aid of microwave absorption. *See Abstr.* 6483

548.7 : 539.169

Creation of displacements in radiation damage. *See Abstr.* 6872

548.7

7008. On the *K* centre in KCl crystal. M. Ueta. *Mem. Coll. Sci. Univ. Kyoto A*, **26**, 69–74 (*Oct.*, 1950).

A KCl crystal is held in a point (cathode)-plane (anode) electrode system at 430°c. Electrons injected from the cathode give rise to a new absorption band at 295 mμ ascribed to a *K*-centre which is removed by heating above 500°c. Absorption in this band excites photoconductivity and a slowly decaying luminescence. Theoretical discussion of the nature of the *K*-centre is given. G. F. J. GARLICK

548.7 : 535.371

7009. Polarized luminescence of *F*-centres in CaF_2. P. P. Feofilov. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 545–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-203.

An intense red luminescence is observed in CaF_2 crystals containing *F*-centres produced additively or by energetic radiations. The excitation spectrum of the emission coincides with the *F*-band attributed to electrons in vacant halogen ion sites. Excitation by plane polarized light gives luminescence with polarization sharply dependent on relation of crystal axes to electric vector direction of the excitation. Plates of CaF_2 with faces parallel to (110) planes show polarized luminescence on excitation with unpolarized light.

G. F. J. GARLICK

548.7 : 535.371

7010. Polarization of the luminescence of *F*-centres in crystals of alkali halides. P. P. Feofilov. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 4, 743–6 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-208.

The polarization of luminescence due to *F*-centre irradiation is examined in LiF and NaF crystals in similar manner to that for CaF_2 (see preceding abstract). LiF shows an orange emission for 436 mμ excitation but a green emission for 365 mμ excitation, while NaF gives a red orange emission with little dependence on exciting wavelength. G. F. J. GARLICK

548.7

7011. Photochemical transformation of *F*-centres in KCl crystals at high temperatures. A. A. Shatalov. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 549–52 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-198.

F-centres produced by heating the crystal to 500°C with sodium electrode for electron injection are not bleached above 300°C. Below this the *F*-band decreases and a new (*X*) band forms at 730 mμ, but on removing the illumination the *F*-band is restored. The new *X*-band is thermally stable below 200°C. It is suggested that the *X*-band is due to the simplest initial form of a coagulation process for *F*-centres. G. F. J. GARLICK

548.7

7012. Polarizability of the *F* and *F′* centres within ionic crystals. M. Trlifaj. *Czech. J. Phys.*, **3**, *No.* 4, 267–81 (1953) *In Russian.*

The polarizability of the neutral *F*- and *F′*-centres in ionic crystals, based on Pekar's model, is calculated in two cases: in the first case the frequency of the electrical field is small compared to the limiting frequency of the vibrations of the ion lattice; in the second case the frequency of the electrical field is large compared to the limiting frequency of the ion lattice vibrations. The calculation uses Kirkwood's variational method, which is equivalent to the second approximation of the perturbational calculus. The values of the polarizability of the *F*-centres are higher by about 20 than the Perlin values, calculated by ordinary perturbation methods. It was found, in accordance with Perlin's results, that the polarizability of the *F*-centres in an electrical field, the frequency of which is large compared to the limiting frequency of the ion vibrations, is smaller than the polarizability of the *F*-centres in an electrical field, the frequency of which is small compared to the limiting frequency of the ion vibrations. Analogous results were obtained for neutral *F′*-centres. Taking into account the calculated values of the polarizability of the neutral *F*- and *F′*-centres in crystals of NaCl, KCl, CuO, BaO and PbS the influence of these centres on the static dielectric constant was investigated. The influence was found to be small at normal concentrations of the centres. A.

548.7 : 535.345

7013. Note on the light absorption in the insulating crystals. T. Ohta. Letter in *Progr. theor. Phys.*, **10**, 472–4 (*Oct.*, 1953).

The shift of optical absorption lines due to excitons is theoretically examined in terms of interaction between excitons and phonons. The resulting trea ment is valid for both polar and non-polar crystals. G. F. J. GARLIC

548

7014. X-ray coloring of 400-MeV proton-irradiat KCl. W. Leivo and R. Smoluchowski. Letter *Phys. Rev.*, **93**, 1415 (*March* 15, 1954).

Large doses of proton irradiation of KCl produce considerable decrease in density without coloratio Such crystals can be more easily coloured subsequen by X-rays than unbombarded crystals, the coloratio extending into the crystal body. G. F. J. GARLIC

548

7015. Distortion of the domain structure of Roche salt crystals by mechanical influence. E. Fische Letter in *Naturwissenschaften*, **41**, *No.* 5, 116– (1954) *In German.*

Observations, with a polarizing microscope, of t domain structure of Rochelle salt crystals und inhomogeneous pressure and around an artificia produced hole in the surface. A. E. DE BA

548.73/.74 : 539.26/.

X-ray and electron investigation of materials. *S Abstr.* 6935–9

548.7

7016. A simple method of obtaining low temperatu X-ray diffraction photographs. S. C. Wallwork a T. T. Harding. *J. sci. Instrum.*, **31**, 163–4 (*Ma* 1954).

A method is described whereby a crystal mount in the usual way on an oscillation goniometer may maintained at a temperature of −30 to −60°C f at least an hour. Liquid air in a vacuum flask boiled by electrical heating and the cold gas is co veyed to the crystal through a well-lagged tube endi in a glass tube supported about 3 mm above t crystal. The temperature may be varied by adjusti the rate of boiling of the liquid air. No precautio against ice formation are necessary.

548.733 : 548.736.1 : 536.4

7017. A pressurized high-temperature Deby Scherrer camera, and its use to determine the structur and coefficients of expansion of γ- and δ-manganes Z. S. Basinski and J. W. Christian. *Proc. Ro Soc. A*, **223**, 554–60 (*May* 20, 1954).

A new, pressurized high-temperature Deby Scherrer camera is described. The structures γ- and δ-manganese are found to be face-centr cubic and body-centred cubic respectively. Accura curves of lattice-spacing against temperature are give for both these phases, and also for the β-manganes phase, and the transition temperatures agree we with other determinations. The mean values of t linear coefficients of thermal expansion of the phas over their regions of stability, and the volume chang resulting from the transformations, are evaluated.

548.7

7018. The determination of pseudosymmetric stru tures. P. Vousden. *Acta cryst.*, **7**, 321–2 (*Apri* 1954).

A method is described for the determination pseudosymmetric structures with a "superstructure i.e. structures where the atoms are only slightly di placed from positions corresponding to a high

mmetry structure in such a way that additional flections result. The advantages of the method are s directness, and its avoidance of the problem of the hermal vibrations. A.

548.734

7019. Tables for direct determination of crystal tructures. V. VAND. *Glasgow: Chemistry Department of the University* (1953) 110 *pp.*

Review in *Acta cryst.*, **7**, 382 (*April*, 1954).

548.734.3

7020. Differential crystallography of powders. . Consideration of the interpretation of Debye–cherrer reflections. II. First-order differential examination. R. FERRO. *R.C. Accad. Naz. Lincei*, **15**, 285–9 (*Nov.*); 408–14 (*Dec.*, 1953) *In Italian.*

From powder photographs of two isomorphous ompounds with slightly different cell dimensions the orresponding lines can usually be identified. From he differences in $\sin^2\theta$ between these corresponding airs of lines, the symmetry and the axes of the unit ell can generally be found. A. R. STOKES

548.735

7021. On the completion and extension of the table of atomic scattering factors published by Viervoll and Ögrim. M. M. QURASHI. *Acta cryst.*, **7**, 310–12 (*April*, 1954).

The table of atomic scattering factors (based on the Hartree self-consistent field) published by Viervoll and Ögrim [Abstr. 7445 (1949)] has a gap between calcium ($Z = 20$) and chromium ($Z = 24$). This gap has been bridged by calculating the screening parameter for the ($3d$) electron in $Ca^+(3d)$. This calculation has been done by a new method, which has possibilities for use with heavier atoms. The atomic scattering factors for scandium to vanadium are tabulated as functions of $s = 4\pi(\sin\theta)/\lambda$. A.

548.735

7022. Intensity of X-ray diffraction by a one-dimensionally disordered crystal. II. General derivation in the case of the correlation range $S \geqslant 2$. J. KAKINOKI AND Y. KOMURA. *J. Phys. Soc. Japan*, **9**, 169–76 (*March–April*, 1954).

For Pt I, see Abstr. 4007 (1954). The general intensity equation for X-rays diffracted by a one-dimensionally disordered crystal, i.e. $I = N\,\text{spur}\,\boldsymbol{VF} + \sum_{n=1}^{N-1}(N-n)\,\text{spur}\,\boldsymbol{VFQ}^n + \text{conj.}$ which was derived for the correlation range $s = 1$ was found to be valid for any s-value by modifying slightly the elements of the matrices. $\overline{S_j S_{j+n}}^*$ as used by Wilson and Jagodzinski was shown to be equal to spur $\boldsymbol{VFP}^n$ for any s-value. In the present method, layer form factors are referred to single layers and the preceding $(s-1)$ layers are used only to classify them into rl-subgroups where r is the number of the kinds of layers and l that of combinations of $(s-1)$ preceding layers. This method (the "antecedent" one) is found to be equivalent to another one as used by Hendricks and Teller in which each layer form factor is taken over the whole s-layers so that there are $R = rl$ different layer form factors (the "whole s-layers" method). The relation between the cases of ranges s and $(s-1)$ is discussed. A simple example is shown in the case of $r = 2$ and $s = 2$. A.

548.735

7023. Intensity of X-ray diffraction by a one-dimensionally disordered crystal. III. The close-packed structure. J. KAKINOKI AND Y. KOMURA. *J. Phys. Soc. Japan*, **9**, 177–83 (*March–April*, 1954).

The general intensity equation for X-rays diffracted by a one-dimensionally disordered crystal with any value of the correlation range s, i.e. $I = N\,\text{spur}\,\boldsymbol{VF} + \sum_{n=1}^{N-1}(N-n)\,\text{spur}\,\boldsymbol{VFQ}^n + \text{conj.}$ was applied to the case of the close-packed structure. The characteristic equation is derived, and from it the difference equations which Wilson and Jagodzinski derived in the cases of $s = 2$ and 3 by the use of rather complicated genealogical tables. A.

548.735

7024. The diffraction of X-rays by close-packed crystals containing both "growth stacking faults" and "deformation or transformation stacking faults." R. GEVERS. *Acta cryst.*, **7**, 337–43 (*April*, 1954).

The general theory is developed of the X-ray diffraction effects exhibited by (*a*) different close-packed structures (h, k, hk, hkk, hhk, $hhkk$ types) containing "growth stacking faults," assuming a four-layer influence; (*b*) hexagonal and close-packed cubic crystals in which "growth stacking faults" and "deformation or transformation stacking faults" coexist; and (*c*) hk- and hkk-crystals (SiC–4H and SiC–6H types) containing "deformation stacking faults." The manner in which a "fault" of the first or second type disturbs the regular sequences of the layers is stated in a general way. Expressions are derived for the reciprocal-space intensity distribution as a function of the parameters (four, two, one, one in the different cases) which describe the densities of the faults. It is shown how these parameters can be determined from measurements of the X-ray intensities or the displacements of the peaks of the diffuse reflections. A.

548.735

7025. A direct approach to the determination of crystal structures. V. VAND. *Acta cryst.*, **7**, 343–6 (*April*, 1954).

A direct method of solution of the X-ray crystallographic problem is described, which consists in tabulating the complete function connecting the structure factor with the atomic positions. The successive steps of the solution can be interpreted as intersections of $(N-1)$-dimensional surfaces in N-dimensional space, where N is the number of unknown co-ordinates. A card index, graphs and tables have been prepared and published for a one-dimensional unit cell with no centre of symmetry containing up to four equal point atoms and, with centre of symmetry, up to ten equal point atoms per cell. Centrosymmetric structures with up to twenty atoms per cell can be solved by a single convolution of the above tables. A.

548.735

7026. Solution of the phase problem for space group $P\bar{1}$. H. HAUPTMAN AND J. KARLE. *Acta cryst.*, **7**, 369–74 (*April*, 1954).

A routine procedure which does not require previous knowledge of any signs has been developed

for determining the signs of the structure factors for space group $P\bar{1}$. Only the magnitudes of the structure factors and the chemical composition of the crystal need to be known. The method developed here is readily extended to all the centrosymmetric space groups, and the general treatment may be found in A.C.A. Monograph No. 3 (1953). A.

548.735.4

7027. A fundamental set of structure-factor inequalities. P. M. DE WOLFF AND J. BOUMAN. *Acta cryst.*, **7**, 328–33 (*April*, 1954).

Among all inequalities between the structure factors related by a given restriction on the indices, the fundamental set is defined as a set of independent inequalities from which all others can be derived. The present paper deals with the problem of finding this set for the structure factors U_H, $U_{H'}$, U_{2H}, $U_{2H'}$, $U_{H-H'}$ and $U_{H+H'}$ for a centrosymmetric structure. Starting from a more restricted problem, viz. to establish relations between some known inequalities, a new inequality is found: $(U_{H+H'} + U_{H-H'} - 2U_H U_{H'})^2 \leqslant (1 + U_{2H} - 2U_H^2)(1 + U_{2H'} - 2U_{H'}^2)$. It is shown that various known inequalities containing the same U's can be derived from this relation combined with three different versions of Harker and Kasper's inequality $(U_H \pm U_{H'})^2 \leqslant (1 \pm U_{H+H'})(1 \pm U_{H-H'})$. The general problem is solved by calculating the extreme values of $U_{H+H'}$ for arbitrary variations of a positive charge distribution in the unit cell, provided the other five U's remain constant. The above four inequalities are found anew, so these constitute the fundamental set. A convenient graphical representation is obtained by plotting the extreme values of $U_{H+H'}$ as a function of $U_{H-H'}$ for given values of the other U's. Finally Karle and Hauptman's inequality $(U_{H\pm H'} - U_H U_{H'})^2 < (1 - U_H^2)(1 - U_{H'}^2)$ is discussed, and is found to be the analogue of the new inequality for the asymmetric case. A.

548.735.46

7028. A photographic method of obtaining Buerger's product function. M. PÉREZ RODRÍGUEZ AND L. CASTRO. Note in *An. Real Soc. Españ. Fis. Quím.*, **49(A)**, 341–2 (*Nov.–Dec.*, 1953) *In Spanish.*

See Abstr. 1334 (1952). The function is obtained photographically by printing from two superimposed photographic representations of the Patterson function, one shifted relative to the other. A. R. STOKES

548.735.7

7029. On the possibility of determining crystal size of crystallites and powder samples in the range $10^{-5} - 10^{-3}$ cm by means of X-rays. A. KOCHANOVSKÁ. *Czech. J. Phys.*, **3**, 53–71 (*March*, 1953) *In Russian. Summary* (1½ *pp.*) *in English.*

Describes a method for the determination of crystal size by comparing the integrated intensities of suitably chosen diffraction lines. The method is applied to graphite and α-quartz. J. THEWLIS

548.735.7

7030. Investigation of the degree of perfection of a crystal by means of polarized X-rays. S. RAMASESHAN AND G. N. RAMACHANDRAN. *Proc. Indian Acad. Sci. A*, **39**, 20–30 (*Jan.*, 1954).

Describes an investigation of the intensity of Bragg reflection when the incident X-rays are polarized and the azimuth of the electric vector is varied with respe to the plane of reflection. It is observed, using natur and ground (211) faces of $NaNO_3$, that the variatio of intensity with azimuth of polarization is differe for a mosaic and a perfect crystal. Such a differen is, in fact, to be expected from theoretical consider tions. The actual behaviour of both the ground an the natural faces was found to be intermediate betwee what is predicted by theory for an ideally perfect an an ideally mosaic crystal. By comparing the observe azimuthal variation of the integrated reflection wi the theoretical expectation for the two limiting case it is possible to assess the degree of perfection the crystal.

548.736

7031. Structure of amorphous antimony. H RICHTER, H. BERCKHEMER AND G. BREITLIN *Z. Naturforsch.*, **9a**, 236–52 (*March*, 1954) *In Germa*

Evaporated layers of Sb are studied, also S produced by electrolysis of $SbCl_3$ solution. Th radial distribution function for amorphous Sb determined by X-ray diffraction and is related to th structure of the crystalline material. The "layer separation in the amorphous state is greater (3·85 than that in the crystalline state (3·37 Å). Th question of the relation between the crystalline an amorphous phases, when present together, is di cussed and attention is paid to the change-over fro amorphous to the crystalline state. J. THEWL

548.736

7032. The β-uranium structure. J. THEWLIS AN H. STEEPLE. *Acta cryst.*, **7**, 323–7 (*April*, 1954).

The non-centrosymmetrical structure put forwar by Tucker and the centrosymmetrical one propose by Tucker and Senio are refined, using the X-ra powder intensities of Thewlis, by a method of tria It is concluded that the non-centrosymmetric structure is correct, with an agreement residual of 19 as against 32%, but that both the main and subsidia layers of atoms in the structure are puckered. I this respect the proposed structure may be considere as a combination of the previous two. A feature the structure is the binding together of neighbourin main layers by short bonds, 2·53 Å in length, betwee certain atoms. This bonding, together with th pairing of neighbouring atoms along the "vertica chains which run through the structure, suggests tendency towards the formation of U_2 molecule A similar tendency is noted in α-neptunium. Aton appear to be present in the structure in four differe electronic states, with valencies of 3, 4, 5 and respectively. These are the valencies exhibited uranium in its compounds. Analysis of the structur based on this valency allocation, shows that the sho inter-layer bonds are intermediate in charact between double and triple bonds, and that the sho bonds along the chains are intermediate in charact between single and double bonds.

548.736

7033. The (*hki*0) reflexions of graphite. G. E. BACO *Acta cryst.*, **7**, 359–61 (*April*, 1954).

Some quantitative data are presented for the shap and position of the *hki*0 reflections of graphite, i the intermediate region between a random-lay

ucture and a true three-dimensional structure. With creasing perfection the reflection rapidly becomes mmetrical but the displacement of the peak creases more slowly. A.

548.736.3

34. A nickel-gallium superlattice (Ni_3Ga). W. B. ARSON. Letter in *Nature* [*London*] **173,** 364 (*Feb.* 20, 54).

This has the Cu_3Au superlattice structure with, like iAl_3, a relatively small homogeneous range and, at w temperatures on the Ni rich side, a wide hetero- neous range, the two coexisting cubic phases ffering considerably in lattice parameter. Ordered i_3X structures are formed when the radius ratio $r_X/r_{Ni} \leqslant 1{\cdot}12$, and the temperature of formation is lated to and increases with this ratio.

A. D. LE CLAIRE

548.736.3

035. "β-Tungsten" as a tungsten oxide. G. HÄGG ND N. SCHÖNBERG. *Acta cryst.*, **7,** 351–2 (*April*, 954).

The existence of "β-W" as a modification of ngsten is contradicted by the low density of the hase and by its decomposition into W and WO_2 at bout 700°c. It is assumed that "β-W" is a metallic ngsten oxide with the probable ideal formula W_3O. he unit cell would then contain 6 W + 2O atoms istributed at random over the eight positions of the 15 structure. A.

548.736.3

036. Interatomic distances in the γ-phase compound Ag_5Zn_8. R. E. MARSH. Letter in *Acta cryst.*, , 379 (*April*, 1954).

548.736.3

037. The boron arrangement in a B_6 hydride. . ERIKS, W. N. LIPSCOMB AND R. SCHAEFFER. etter in *J. chem. Phys.*, **22,** 754–5 (*April*, 1954).

This is determined from X-ray measurements on a ingle crystal. The unit cell is ortho rhombic. Space roup $Cmc2_1$. Interatomic distances of the boron toms are given. C. TURNER

548.736.3 : 539.133

038. On the inequality of metal-oxygen bond engths in some metal oxides and on the "molecular" tructure of ZnO. G. S. ZHDANOV AND V. A. OSPELOV. *Dokl. Akad. Nauk SSSR*, **93,** *No.* 1, 97–9 1953) *In Russian.*

The artificial mineral Ti_3O_5 consists of octahedra iO_6 of distinct types, one of which shows a shortening of the Ti–O bond by 0·2 Å. Such an inequality of onds was expected also in ZnO. An X-ray analysis of crystalline zinc-oxide showed that this is not the ase; deviations from the ideal value $\sqrt{(8/3)}$ of c/a re due to deformations of the valence angles rather han to unequal interatomic distances. Hence the dea of "molecular" structure in crystalline zinc-oxide s not confirmed. J. JACOBS

548.736.4

7039. The crystal structure of Mg_6MnO_8. J. S. KASPER AND J. S. PRENER. *Acta cryst.*, **7,** 246–8 (*March*, 1954).

Cubic, space-group $Fm3m$, $a_0 = 8{\cdot}381$ Å; $4Mg_6MnO_8$ per unit cell. The oxygens form a slightly distorted close-packed arrangement, and there is an ordered arrangement of metal ions and of holes in the octahedral interstices, in agreement with Bertaut's theoretical conclusions [Abstr. 8061 (1953)].

A. R. STOKES

548.736.4 : 537.226.2

The properties of colloidal ferroelectrics; barium titanate. *See Abstr.* 6590

548.736.5

7040. An X-ray examination of the spinel-type mixed oxide, $MgFeAlO_4$. G. E. BACON AND A. J. E. WELCH. *Acta cryst.*, **7,** 361–3 (*April*, 1954).

The use of X-ray powder diffraction methods for determining the oxygen parameter and cation distribution in $MgFeAlO_4$ is described, with particular reference to the effect of *K*-electron dispersion on atomic scattering factors. A.

548.74

7041. Fine structure due to refraction effect in electron diffraction pattern of powder sample. II. Multiple structures due to double refraction given by randomly oriented smoke particles of magnesium and cadmium oxide. G. HONJO AND K. MIHAMA. *J. Phys. Soc. Japan*, **9,** 184–98 (*March–April*, 1954).

For Pt I, see Abstr. 4034 (1954). Fine structures composed of sets of doublets as expected by the double refraction effect, an effect concluded by the dynamical theory of electron diffraction, are studied in detail for reflections given by individual smoke particles of magnesium and cadmium oxides having random orientations. The configurations of doublets vary according not only to the azimuths of the crystallites but also to the angles of deviations from Bragg condition, namely, the errors of resonance of Bragg reflections. By determining these two parameters from the configuration, the mean and periodic terms of the Fourier expansion of the inner potentials of the crystals are obtained from the inter-doublet and intra-doublet separations in the fine structures. The results show a reasonable agreement with the theoretical values. The intensity anomaly of the double refraction effect, suggested in Pt I, is found to be a general phenomenon. It is observed that between the two spots of a doublet, that of larger deviation is always weaker in intensity than its companion of smaller deviation, and that the intensity difference is more conspicuous for strong reflections, that is to say, reflections which show large double refractions. This anomaly seems to be explained when complex periodic inner potentials are assumed for crystals. A.

548.74

7042. A study of anomalous refraction effect in electron diffraction. I. Magnesium oxide and cadmium oxide smokes. S. KUWABARA. *J. Sci. Hiroshima Univ. A*, **17,** 111–13 (*Aug.*, 1953).

The application of a three-stage electron microscope to the study of anomalous effects in the diffraction pattern from magnesium and cadmium oxides is described. Split lines and spots are explained in terms of refraction by the inner potentials of the crystals. Calculated results agree well with measurements in the case of magnesium oxide, but not for cadmium oxide. M. E. HAINE

548.74

7043. Techniques and applications of neutron diffraction. M. K. WILKINSON. *Amer. J. Phys.*, **22**, 263–76 (*May*, 1954).

A brief review is given of the advances which have been made in the field of neutron diffraction during the past several years. The experimental techniques that have been developed are discussed, and illustrations are cited of several fields of application where information is obtained which would be very difficult or impossible to obtain by X-ray or electron diffraction. A.

548.74 : 537.533.2

7044. On an observation with the Müller microscope. J. NIKLIBORC. *Acta. phys. Polon.*, **12**, *No.* 3–4, 244–5 (1953).

The structure of an image obtained with a tungsten point at a temperature just above red heat suggests the existence of a large number of small facets at surface of the point. C. G. MORG

548.74 : 539.2

7045. On the structure of thin layers of alk halides evaporated on single crystal substrates. LÜDEMANN. *Z. Naturforsch.*, **9a**, 252–9 (*Mar* 1954) *In German.*

The thin layers are evaporated on alkali hal cleavage faces and their growth studied by electr diffraction. The growth of crystals of one substa on another and one substance on the same substanc studied and particular attention is paid to the velopment of twins. The latter is also studied electron microscopy. J. THEW

548.74 : 539

Study of thin crystalline films by universal elect diffraction microscope. *See Abstr.* 6939

GEOPHYSICS 55

550.341

7046. Longitudinal and transverse waves guided in the low velocity layer [astenosfera]. P. CALOI. *R.C. Acad. Naz. Lincei*, **15**, 352–7 (*Dec.*, 1953) *In Italian.*

It is suggested that the layer approximately 100 km below the earth's surface (astenosfera) may act as a conducting duct for seismic waves with an epicentre at about this depth; this is because the layer has increasing velocity of wave propagation at both its upper and lower limits. Preliminary evidence is produced in favour of this idea. J. M. HOUGH

550.38

7047. An earth current deep underground in N. Germany during earth-magnetic "Bay" disturbances. U. FLEISCHER. *Naturwissenschaften*, **41**, *No.* 5, 114–15 (1954) *In German.*

A diagram shows for the three magnetic components, D, H and Z a typical earth magnetic "Bay" for 6 stations in N.W. Europe. In this and all similar cases, the changes for D and H are alike, but Z changes from north to south, indicating an anomaly of conductivity below ground which influences the earth current. The anomaly was established by earth magnetic measurements with a portable Askania variograph at a depth of about 85 km and latitude 53·2° N. R. S. READ

550.93 : 539.16.08

7048. Some problems in radiocarbon dating. E. C. ANDERSON AND H. LEVI. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **27**, *No.* 6, 21 *pp.* (1952).

A detailed comparison of the screen-wall counter with a gas sample counter with respect to the problems of radiocarbon dating is given. Curves are presented showing the accuracy and range of the method as functions of the background rate and the counting time. The errors due to intrusion of extraneous carbon are presented and discussed and certain improvements in the method are described. A.

550.93

7049. On the geological age determination of potassium feldspar by the potassium–argon method. W. GENTNER, F. JENSEN AND K. R. MEHNERT. N in *Z. Naturforsch.*, **9a**, 176 (*Feb.*, 1954) *In German.*

The method gave the age as 223×10^6 years $\pm$ 20 J. HUG

ATMOSPHERE . METEOROLOGY 551.5

551.508

7050. New recording rain-gauges. J. F. NAG *J. sci. Instrum.*, **31**, 158–62 (*May*, 1954).

Two automatic rain-gauges, in which the syphon principle is applied, are described; one is of the da type and the other is designed to record continuou for 200 days. It is shown that errors in the syphon device are insignificant. Because of three char teristics: (i) a large drum of 180 mm diameter cove with waxed paper, (ii) a very thin record line made a fine scriber, and (iii) a mechanism which contr lateral movements of the recording scriber wit very fine limits, the daily gauge makes it possible evaluate rainfall over a very short interval, of an or of $\pm$ 1 min and to an accuracy of $\pm$ 0·1 mm. T instrument which records for 200 days is of necess less accurate, measuring the amount of rainfall within $\pm$ 0·2 mm and the time to within $\pm$ 15 m Both instruments are provided with an appropri wind shield.

551.510

7051. The abundance of atmospheric carbon m oxide at Jungfraujoch (Switzerland). W. BENESCH, MIGEOTTE AND L. NEVEN. *J. Phys. Radium*, 213–15 (*March*, 1954) *In French.*

High-dispersion infrared solar spectra recorded the international scientific station on the Jungfra joch, 1950–51, have been analysed to obtain an es mate of CO concentration above the station which sufficiently remote from terrestrial pollution to ma the measures representative of the natural distributi of the gas in the upper atmosphere. Significant, ra

anges in concentration are found which suggest the stence of CO currents and "cells" within a limited dius of the observing site. No significant correlation of CO abundance with the local meteorological uation is found. The max. concentration observed as 0·75 atm. cm. on April 25, 1951, and the min. ncentration, 0·17 atm. cm. on August 20, 1950.
D. R. BARBER

551.510.41

52. **Continuous measurement of atmospheric ozone an automatic photoelectric method.** R. STAIR, C. BAGG AND R. G. JOHNSTON. *J. Res. Nat. Bur. and.*, **52**, 133–9 (*March*, 1954).

An automatic photoelectric instrument and method r the continuous measurement of the ozone in the rth's atmosphere at low altitudes are described. ne method is physical rather than chemical in aracter and is based upon the optical absorption aracteristics of ozone in the Hartley and Huggins traviolet bands. The instrument makes use of a w-pressure mercury arc, which is situated at a stance of 1 450 ft from the recording station that nploys a 1P28 photomultiplier as a detector. The ght beam is modulated, at 510 c/s, so that the output the photomultiplier is fed into a tuned alternating-rrent amplifier and amplified to the recorder level. y means of a Geneva mechanism, which changes the ass filters, the radiant energy from the lamp is parated into bands primarily at wavelengths 253·7, 55·5 and 405·0 mμ. From the ratios of the deflec-ons for the different spectral regions it is possible determine ozone concentration in the range from a w tenths of 1 part to many parts per 100 million. A.

551.510.5

053. **The physical state of the upper atmosphere.** . WEEKES. *Quart. J. Roy. Meteorol. Soc.*, **80**, 2–15 *an.*, 1954).

A detailed survey of modern knowledge relating to ne physics of the atmosphere lying above 20 km. spects discussed are: (1) composition of the atmo-here with particular reference to diffusive separation nd photochemical action: (2) temperature and pres-ure at different levels; (3) densities and temperatures erived from rocket measurements in range, 0–150 km; (4) winds of the high atmosphere; (5) movements of nization in the ionosphere deduced from radio-oundings and their relation with geomagnetic and eoelectric fields. A useful bibliography of 46 refer-nces is appended. D. R. BARBER

551.510.535

054. **Plasma theory of the ionosphere.** I. LUCAS ND A. SCHLÜTER. *Arch. elekt. Übertragung*, **7**, 7–30 (*Jan.*, 1954) *In German.*

The basic equations for the dynamic and electrical ehaviour of the ionosphere are derived from the nown theory of a plasma with neutral gas. The quations lend themselves for the treatment of a umber of ionospheric problems, such as the diffusion f the plasma at the layer boundaries, the electro-agnetic damping of air movements and the tidal scillations of the ionosphere. The general equations re specialized for application to the problem of the des. A.

551.510.535

7055. Motion of the storm-*D* regions. V. AGY. Letter in *Nature* [*London*] **173**, 445–6 (*March* 6, 1954).

A consideration of the diurnal variation of instances of no-echo at Washington (one cause of which is excessive absorption blackout). Contour plots do not show a 48 hr rotation of "storm-*D*" regions suggested by Piggott [Abstr. 2845 (1953)]. G. M. BROWN

551.510.535

7056. Origin of the ionospheric *E* layer. K. RAWER AND E. ARGENCE. *Phys. Rev.*, **94**, 253–6 (*April* 15, 1954).

The intensity of solar soft X-rays (50–230 Å) as computed by Elwert is found to be sufficient to cause the ionization of the ionospheric *E*-layer. On the other hand, pre-ionization of molecular oxygen by u.v. chromospheric radiation ($\lambda < 1020$ Å, Nicolet) could perhaps also be admitted, if it could be accepted that the dissociation of atmospheric oxygen occurs in a high transition layer of considerable thickness (100–150 km). The first process is probably predominant. A.

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 6743–7

551.521.1 : 628.8 : 536.453

The present and future utilization of solar energy. *See Abstr.* 6557

551.593.9

7057. The formation of atmospheric O_2 emission in the airglow. J. W. CHAMBERLAIN. *Astrophys. J.*, **119**, 328–33 (*March*, 1954).

A suggestion by Bates, that absorption of the O_2 atmospheric 0–0 band followed by emission of 0–1 may be an important source of the observed airglow O_2 emission, is investigated quantitatively. An approximate equation of radiative transfer is solved and applied to a model atmosphere. In the limiting case of no collisional de-excitation, Bates's fluorescent mechanism could account for about 75% of the observed emission, and this portion would arise from a layer at about 50 km. The low rotational temperatures that have been determined for the 0–1 band are tentatively interpreted as an effect of collisional de-excitation and thus may not represent kinetic temperatures. A.

551.593.9

7058. Results of photometric observations of the light of the night sky. D. BARBIER. *C.R. Acad. Sci.* [*Paris*] **238**, 770–2 (*Feb.* 15, 1954) *In French.*

Provisional results of observations with a new photoelectric photometer at the Observatory of Haute-Provence in 1953 are described with particular reference to the co-variation of 2 groups of emission features in the night-sky spectrum, viz. group (*a*): [OI] line at 5577 Å, continuum, Herzberg bands, and blue emission bands; group (*b*): [OH] bands, Na [D] lines and [OI] lines at 6300, 6364 Å. Various correlations have been found for (i) intensity variations during the course of the night, and (ii) variation from month to month of the degree of co-variation of selected pairs of emissions, e.g. ratio, 5577 Å/other radiations of group (*a*), and Na [D] lines/[OH] bands. D. R. BARBER

551.594.51

7059. The possible rôle of accelerated secondary electrons in the aurora. C. Y. FAN. Note in *Astrophys. J.*, **119**, 294 (*Jan.*, 1954).

Laboratory experiments with electrons of energies between 0·2 and 7 keV have shown that only electrons of energy <400 keV (the energy required for protons to penetrate to the 110 km atmospheric level) can excite the Meinel and first-positive systems of N_2^+, N_2 to produce the intensity ratio observed in the aurora. For the auroral radiations, secondary electrons accelerated to energies of several hundred volts by a vertical potential gradient in the auroral region are the most likely source. The potential gradient results from the deeper penetration of protons present in the solar proton-electron stream.

D. R. BARBER

551.594.

7060. Magnetic disturbances, sporadic *E*, and rad echoes associated with the aurora. J. H. MEEK AN A. G. MCNAMARA. *Canad. J. Phys.*, **32**, 326- (*May*, 1954).

A comparison of simultaneous data on the visib aurora, the earth's magnetic field variation, vertic and oblique ionosonde echoes, and very-hig frequency radar echoes has been made. Long-ran high-frequency and very-high-frequency radio echo do not appear to correlate individually. Reflectio are observed, however, on both frequency rang coincident with the appearance of low elevati auroral arcs, which are associated with magne bays.

551.594.6 : 538.566.2

The scattering of electromagnetic waves by turbule atmospheric fluctuations. *See Abstr.* 6748

BIOLOGY 57/59

578.087.87 : 591.112.2

7061. Determination of the resultant dipole of the heart from measurements on the body surface. D. GABOR AND C. V. NELSON. *J. appl. Phys.*, **25**, 413–16 (*April*, 1954).

By means of the vector calculus, it is proved that the magnitude, orientation, and location of the resultant dipole of a system of sources and sinks inside a finite volume conductor is given by an integration over the bounding surface. The method is applied to finding the "heart vector," or the resultant dipole moment of the human heart. The theory was checked in two- and three-dimensional electrolytic tank models of the human thorax. A.

578.088.2 : 534.2

Ultrasonic transducer suited for use on biologic material. *See Abstr.* 6391

MEDICAL SCIENCE . HUMAN PHYSIOLOGY

615.825.65 : 534.321.9 : 534.2

Acoustic performance determination during ther peutic treatment with ultrasonic apparatus. *S Abstr.* 6389

PHOTOGRAPHY 77

778.34 : 539.172.13

Nomograms for neutron track calculations in nuclear emulsions. *See Abstr.* 6892

778.34 : 539.185.08

7062. Boron-loaded photographic plates as detectors of slow neutrons. A. R. BAKER. *J. sci. Instrum.*, **31**, 187–9 (*May*, 1954).

The variations with position in the plate of the emulsion thickness and of the number of slow neutrons recorded per unit area have been determined for 10 in. × 8 in. × 100 μ boron-loaded plate that had be irradiated uniformly with slow neutrons. T measurements were consistent with a constant co centration of boron throughout the plate and upp limits were placed on possible variations. Co parative slow neutron flux measurements with dis of stripped emulsion from the same sheet should ha a standard error of 3% at most.